RENEWABLE ENERGY POTENTIAL AND ITS CONSUMPTION IN VILLAGE BERKA ALIMUDDIN OF HARYANA

(Tehsil: Nuh; District: Gurgaon)

Ranjan Kumar Bose

Discussion paper no. 05/87

TATA ENERGY RESEARCH INSTITUTE
7, Jor Bagh, New Delhi 110 003
November 1987

ACKNOWLEDGEMENTS

The author wishes to express his deep gratitude to Dr. Veena Joshi, Mrs. Charu Puri and Dr. Syed Moinbasha of TERI for their useful comments and suggestions at various stages of the study.

The author would also like to extend his thanks to Shri Sanjay Kothari, IAS, former Deputy Commissioner and Chairman, Mewat Development Agency, Gurgaon, for his help in selecting and working in the village.

The co-operation and assistance provided by the Panchayat members of the village is gratefully acknowledged. The author is indebted to each resident of the village 'Berka Alimuddin' and their families for permitting him to subject them to intensive questioning for filling up long household schedules. He is also indebted to local field investigators, Shri Musa Khan, Shri Yunus, Shri Illias, and Shri Isaq in helping with the data collection work from each household in the village. But for their untiring work and keen interest, it would have been difficult to complete this study.

The author is thankful to Miss Savitri Rawat who worked diligently in typing the report.

Last, but not the least, grateful thanks are due to Miss Sharmila Sengupta and Mrs. Namita Bhatia for their meticulous editorial assistance and all their efforts in bringing out the report.

November 1987

Ranjan Kumar Bose

CONTENTS

LIST OF TABLES

LIST OF FIGURES

Abstract

During the latter half of 1985, an energy census was conducted by Tata Energy Research Institute professionals in village 'Berka Alimuddin' in the Gurgaon district of Haryana state. The objective was to assess the renewable energy resource potential and to understand the utilization pattern of energy sources in major domestic and agricultural activities in the village. Based on the survey results, an attempt has further been made to estimate the energy requirement of the village in 2001 AD. The approach used for estimating the future energy requirement in the village households is an analysis of the information and data available on the energy consumed in different end-uses and the changes in population distribution of households. On the other hand, in the agriculture sector, energy consumption norms have been worked out for per acre of crop produced for the two major energy intensive agricultural activities viz. land preparation and irrigation. Then, using these norms based on certain assumptions on the cropping pattern and the level of mechanization, the total energy requirement in 2001 AD has been presented for land preparation and irrigation.

Keywords

Renewable Energy, Resource Potential, Energy Demand, Village, India.

INTRODUCTION

The Tata Energy Research Institute, New Delhi, conducted an energy census of village Berka Alimuddin in the Gurgaon district of Haryana State to assess the total energy needs and to study the utilization pattern of biomass and other energy resources in major domestic and agricultural activities. The reference period of the survey was July-September 1985. The general information about this village is given in Annexure I.

SCOPE OF THE STUDY

A detailed analysis of energy consumption was carried out in Berka Alimuddin, a village located in the semi-arid region of Gurgaon. The scope of the study was to understand the details of energy consumption patterns and their inter-relationships with the major economic variables in household and agricultural activities. The objectives of the study were:

(i) to get a geographic/socio-economic picture of village Berka Alimuddin which would describe the major domestic and agricultural activities in relation to the mix of energy requirement for meeting each of the major activities,

(ii) to construct a matrix depicting the village gross energy requirement with reference to domestic and agricultural activities,

(iii) to quantify the specific energy consumption for different end-uses,

(iv) to assess the energy equivalent of biomass obtained in the village ecosystem, and

(v) to carry out a forecast of energy demand by end-use for the year 2001 AD.

MATERIALS AND METHODOLOGY

Survey Methodology

A detailed pre-tested field questionnaire was distributed in all the households in Berka Alimuddin. The questionnaires were filled in by four investigators, who were selected from the same village; they underwent 7-10 days' training for conducting the survey.

The first round of energy consumption assessment was conducted in July 1985. This involved the listing of all households in the village. Along with the listing, a village schedule was also filled in, using the available information at the block level, supplemented with the information gathered from the village elders. The schedule aimed at identifying and collecting essential information on all important aspects of different rural activities -- including energy consumption -- thereby getting an overall picture of the rural environment in the context of energy usage in domestic and agricultural activities. A copy of the village schedule is given in Annexure II.

The detailed household level information was collected by means of a census survey during the Rabi harvesting period

i.e., September 1985. The household schedule was designed and pre-tested to collect data on major aspects of domestic and agricultural consumption of both biomass and non-biomass energy sources. The energy consumption data for various domestic activities, viz. cooking, lighting and water heating were to cover the last reporting month, i.e. August 1985, which is a summer month. Relevant information pertaining to demography and land use was also collected. Apart from energy consumption in domestic activities, information was also collected on energy consumption for various agricultural activities, viz. land preparation, irrigation, application of fertilizers, threshing, etc. by different categories of landowners.

One of the difficulties faced in household level surveys was the inability of the respondent to quantify correctly. His spontaneous responses to questions involving quantification were often wide off the mark. Keeping this in view, the household schedule was designed with built-in crosschecks on data, and all questions were structured in such a way as to probe the respondent to arrive at the most reliable estimates of the quantities involved. For example, in, section I (Annexure III), information was asked both on foodgrain consumption in physical units as well as the quantity purchased. Similarly, in section I (Annexure II), to estimate the commercial energy consumption in households we collected information both on consumption of energy sources and physical and monetary units.

Information was also collected for different types of crops produced and their distribution as consumption, wage, fodder and quantity sold. Crop production data was collected to assess the crop residue potential -- cropwastes used both as fuel and fodder. Other than these, data on cattle and dung production were also collected. Annexure III contains a copy of the household schedule used for this purpose.

It may be mentioned that we have used a very detailed questionnaire (Annexures II and III) in order to understand the energy requirements in various domestic and agricultural activities at a village level. This would help us in understanding the flow of various energy sources, particularly biomass for various operations.

The survey was completed in the last week of September 1985. TERI staff verified the filled-in schedules through verifying the data by going back to the same household.

Processing of the Collected Data

The data collected at the household level was coded and processed, using a computer. The data compiled for each household was aggregated at the village level into two sets of land-holding classifications, viz. land ownership classification and land under cultivation.

Land Ownership

The mix of domestic energy consumption for different activities varies among different income categories. It was

found that it is very difficult to assess the actual income of a rural household. Hence, instead of classifying the households on the basis of income, they have been categorized according to land owned by each; this has been done because land ownership is one of the major indicators of income. Thus, the compiled household data related to domestic energy consumption has been disaggregated into six land ownership categories, namely:

I	Large farmer	(over 10 acres of land)
II	Medium farmer	(5 to 10 acres of land)
III	Small farmer	(2.5 to 5 acres of land)
IV	Marginal farmer	(upto 2.5 acres of land)
V	Landless labourer	
VI	Others	

Land Under Cultivation

Similarly, energy required in different agricultural activities for crop production depends on the crop land under cultivation. Thus, the compiled household data related to agricultural energy consumption has been disaggregated into four land under cultivation categories, namely:

A	Large farmer	(over 10 acres of land)
B	Medium farmer	(5 - 10 acres of land)
C	Small farmer	(2.5 - 5 acres of land)
D	Marginal farmer	(upto 2.5 acres of land)

Energy Conversion Units

All the energy consumption figures in metric units have

been converted into the corresponding energy units, i.e. kCal by using the same conversion units suggested by the National Council of Applied Economic Research in their study on 'Rural Energy Consumption in Northern India'[1]. Table 1 provides the conversion of original units to energy units (kCal).

Table 1: Conversion of Original Units to Calorific Value (kCal)

Fuel	Unit	kCal/Unit
Dungcake	Kg	2100
Logs	Kg	4750
Twigs	Kg	4700
Crop-residue	Kg	3500
Coal	Kg	5700
Kerosene	litres	8547
Electricity	Kwh	861
Diesel	litres	8926
Animal power	Animal hr.	2300

GENERAL DESCRIPTION OF THE AREA

This section provides a geographic/socio-economic picture of village Berka Alimuddin, i.e. its ecosystem,, land use pattern, land holdings, irrigation inputs, cropping pattern, etc. and describes the major domestic and agricultural activities in relation to the mix of energy requirement for meeting each of the major activities.

Village Location

Berka Alimuddin, which falls under Block and Tehsil Nuh and District Gurgaon of Haryana State, is situated about 16 kms to the north of Nuh. The village is connected by tarred road. Its approximate longitudinal location is $27^{\circ}10\ 55''$ to $28^{\circ}12\ 30''$ E and latitudinal location is $76^{\circ}59\ 30''$ to

77°1 20" N. This village is surrounded by four villages: in the east, by village Pachgaon, on the west side by village Barwa, in the north by Mahawan and on the south side by Durgapur. The exact location of the surveyed area is shown on the Block Map (See Figure 1).

Physiography and Drainage

The elevation of the area surveyed ranges from 210 to 215 metres above mean sea level. The major slope of the terrain is from west to east; the slope gradient of the area ranges from 210 to 215 metres, mostly on the west side of the village. The east being the lowest-lying area, the water of the whole area is drained out towards it. Figure 2 gives the detailed map of land physiography of the village.

The following broad physiographic features are observed in and around the village:

(i) Plain area

(ii) Slightly undulating area

(iii) Undulating area

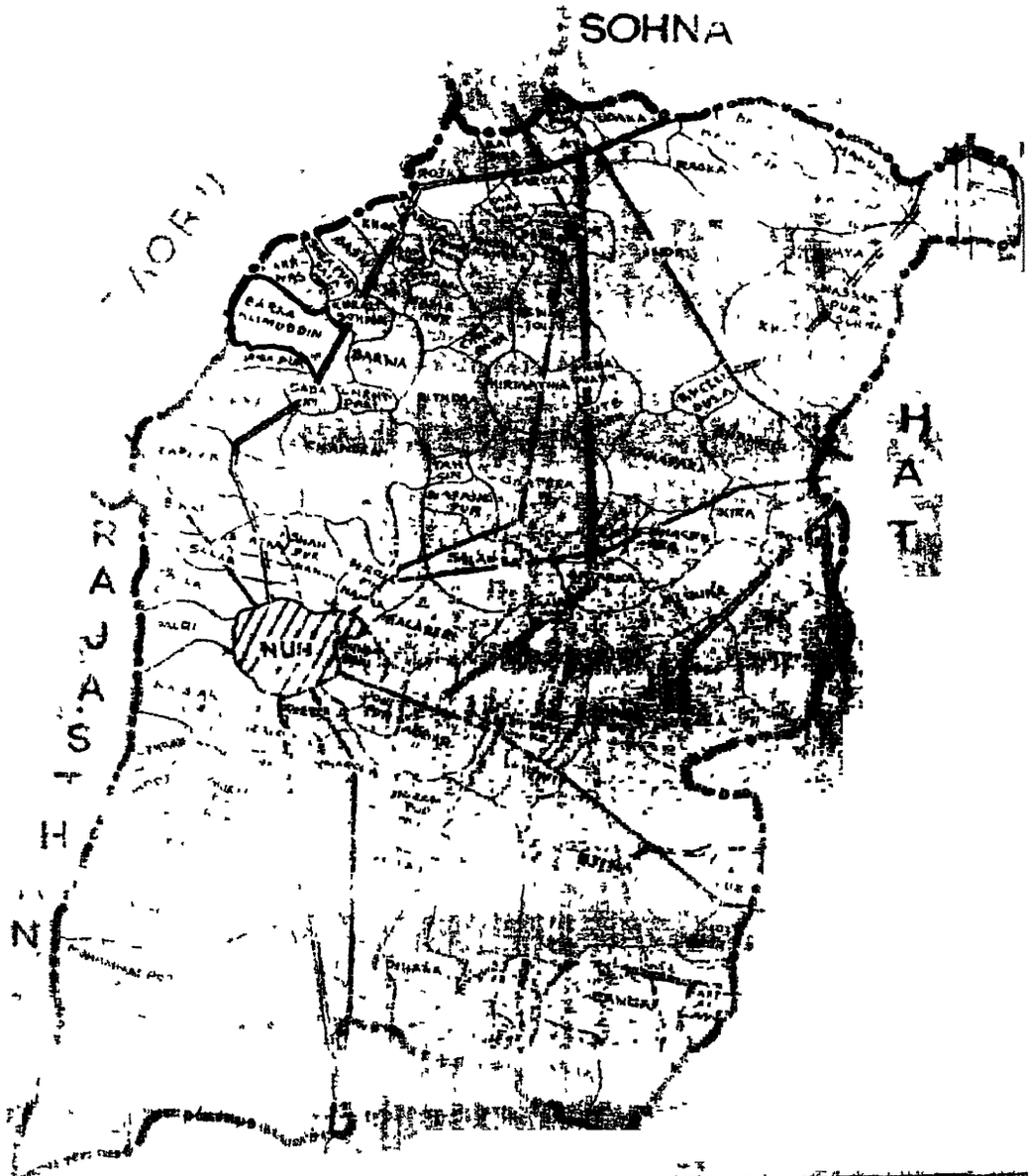
(iv) Water logged area

(v) Denuded hills

Geology

The plain area comprises of soil which is loamy sand to loam in texture. The soil mantle varies from shallow to very deep with water table at 2 to 30 feet. Figure 3 gives a full picture of the distribution of soil

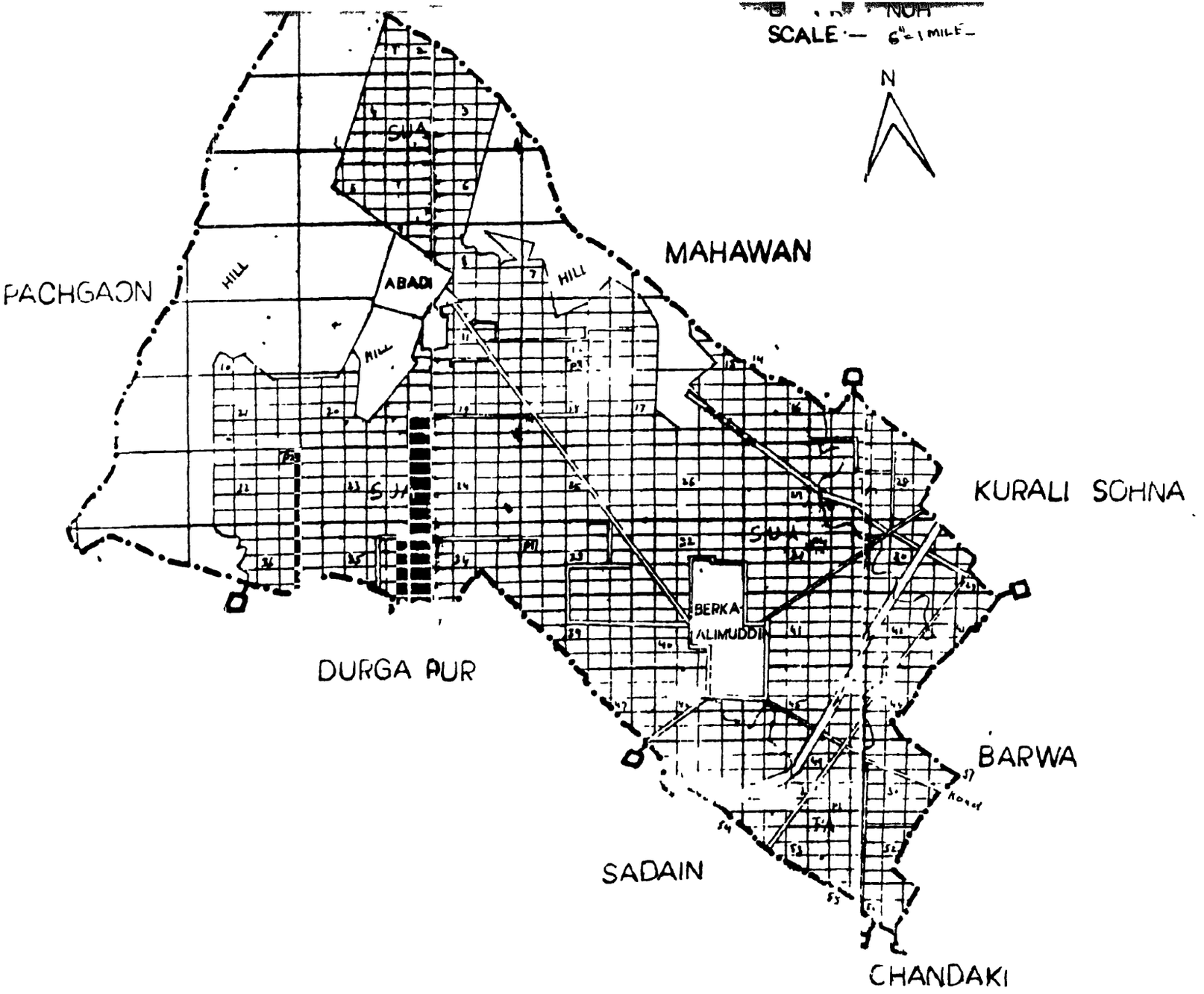
MAP OF BLOCK NUH
DISTT. GURGAON



REFERENCE

1. BLOCK BOUNDARY.....
2. VILLAGE BOUNDARY.....
3. URBAN AREA.....
4. ROAD.....
5. CANAL.....

DRN BY G.P. GIRG	DY. DIR.	
CKD BY Z A ANSAR	S.S.O.	
APPD BY U GULATI I.A.S.	C.P.O.	
	C.A.D. AUTHORITY	



VILLAGE: BERKA ALIMUDDIN

S.NO.	MAPPING UNIT	DESCRIPTION
1.	S.U.A.	SLIGHTFLY UNDULATING AREA, B-SLOPE, CULTIVATED LAND.
2.	P.A.	PLAIN AREA, ALMOST LEVEL, CULTIVATED LAND.

Fig. 2

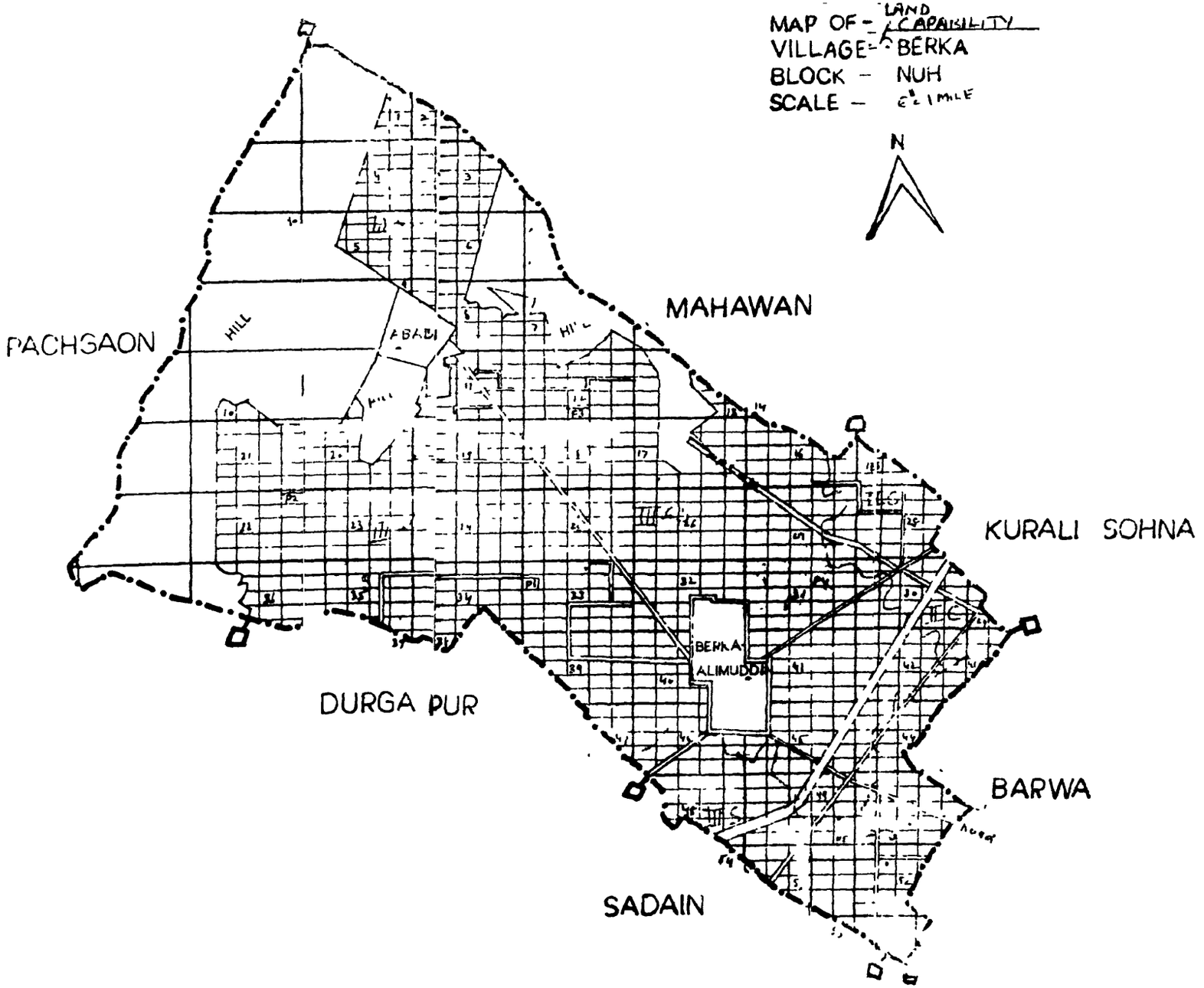


Fig. 3

VILLAGE: BERKA ALIMUDDIN

S.NO.	MAPPING UNIT	DESCRIPTION

texture in the village. The soil ranges in texture from coarse to fine. Fine texture soil contains excessive soluble salts with pH varying from 7.5 to 10.9, which hampers internal drainage. Being saline and sodic in character, these soils would require a long period of leaching.

Climate

The village is subjected to three climatic periods:

(i) A hot dry windy period- Summer season (April to June)

(ii) A medium moist period - Monsoon season (July to September)

(iii) A cold dry period - Winter season (October to March).

The village remains dry for about 280 days in a year; with mid-season droughts during the monsoon, 60 per cent of the days are dry. The temperature starts rising continuously from April right through June. The maximum temperature reaches upto 45°C in the month of May and the minimum falls to as low as 1.1°C in January. The daytime winter temperature varies from 27.3°C to 33.0°C. High temperature, coupled with high wind velocity and lack of soil moisture are the main characteristics of this area. The mean temperature recorded during the year 1980 is given in Table 2.

The monsoon showers begin in June and as much as 6.7 mm of rain is received by the village in this month; the season extends over September, when as much as 142.1 of rain is received. Some rain is also received in winter from the

Table 2: Temperature ^{o}C

Month	Highest	Lowest	Mean
January	27.3	1.1	14.2
February	33.0	2.5	17.8
March	33.0	6.3	20.0
April	43.7	14.0	28.8
May	45.0	19.5	32.2
June	44.8	23.4	34.1
July	39.5	32.5	31.0
August	37.5	22.3	29.9
September	37.7	19.0	28.3
October	37.4	13.0	25.2
November	30.2	8.6	19.4
December	27.5	3.8	15.6

North-easterly winds and these play a vital role in the success of the 'Rabi' or winter crops. The extent of rains during December to February is 27.1 mm. The annual average rainfall of this area is 788.1 mm. The data of rainfall is being received from the nearest rain gauge station at Ballabhgarh. The average weighted rainfall from 1971 to 1980 (10 years) as collected at Ballabhgarh is reproduced below in Table 3.

The mean wind velocity (as recorded for the year 1980) varies from 2.1 km per hour during the month of January to 7.5 km per hour during the month of June. High wind velocity hampers the growth of vegetation considerably. The data on the mean wind velocity recorded in 1980 at 08.30 hours (IST) is given in Table 4.

The erratic rainfall, high wind velocity and high temperature considerably accelerate the rate of evaporation,

Table 3: Rainfall Data Recorded at Gauge Station Nuh, Block Nuh, District Gurgaon, for the Period 1971-1980 (mm)

Year	January	February	March	April	May	June	July	August	September	October	November	December	Total
1971	12.0	-	-	-	75.4	58.3	235.2	275.8	-	-	-	-	656.7
1972	35.0	-	-	-	-	59.2	221.2	240.0	18.0	17.0	35.0	-	625.4
1973	5.4	9.0	2.0	-	34.0	3.0	208.0	469.0	125.3	-	-	5.0	871.3
1974	-	-	-	-	-	13.0	320.0	135.0	24.0	18.0	-	9.9	515.9
1975	6.0	-	17.0	-	4.5	78.0	194.0	245.3	253.8	-	-	-	799.0
1976	-	36.5	-	-	65.0	88.7	271.0	267.0	7.0	-	-	-	735.2
1977	24.0	-	0.7	32.2	20.3	120.2	328.0	71.0	24.0	-	-	5.0	625.4
1978	-	15.2	35.5	12.0	-	56.0	260.0	222.5	169.0	-	-	13	783.2
1979	6.0	30.0	6.0	-	10.5	45.05	84.0	10.0	15.0	-	3.0	23.0	237.4
1980	-	-	29.0	-	24.0	66.0	115.0	62.0	71.0	2.0	-	-	369.0

Source: D.C. Office, Gurgaon.

Table 5: Demographic Details of Village Berka Alimuddin According to Land-owned Classification

Type	Household category according to land ownership	No.of house-holds	Number of adults				Number of children(< 18 yrs.)				Sum Total			
			Male	Female	Total	Av/family	Male	Female	Total	Av/family	Male	Female	Total	Av/family
I	Large farmer	13	32	28	60	4.62	28	24	52	4.33	60	52	112	8.62
II	Medium farmer	23	38	27	65	2.83	34	29	63	2.74	72	56	128	5.57
III	Small farmer	33	51	44	95	2.88	45	39	84	2.90	96	83	179	5.42
IV	Marginal farmer	31	39	30	69	2.23	36	32	68	2.72	75	62	137	4.42
V	Landless labourer	68	95	78	173	2.54	70	65	135	2.65	165	143	308	4.53
VI	Others	7	8	7	15	2.14	5	4	9	3.00	13	11	24	3.43
All classes together		175	263	214	477	2.85	218	193	411	2.94	481	407	888	5.07

which is naturally at its highest during the hottest period of the year i.e. April to June.

Table 4: Average Wind Velocity (Km/hr)

Month	Velocity
January	2.1
February	5.4
March	5.0
April	5.6
May	6.7
June	7.5
July	4.8
August	2.6
September	4.4
October	4.0
November	2.7
December	3.7

Figure 4 gives an overview of the metereological diagram of 1980 for the entire district of Gurgaon.

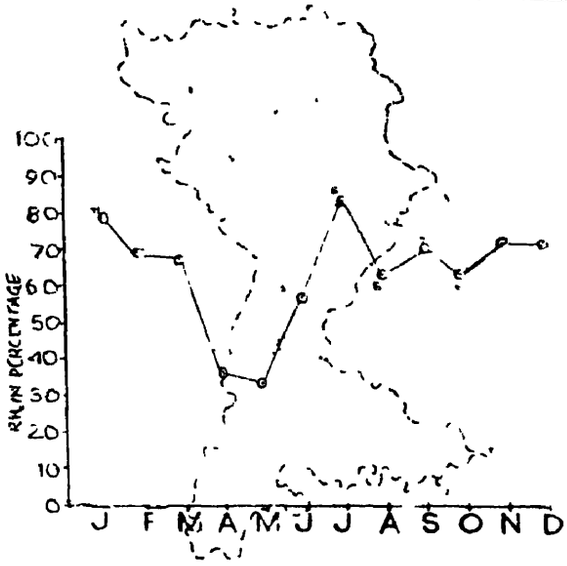
Population

The village has 175 households with a total population of 888 including 263 adult males, 214 adult females and 411 children below 18 years of age. The total number of landowing families is 100, landless (labour) households being 68 and others 7 (which includes the families of a shop owner, a tailor, a school teacher, two blacksmiths and two potters, respectively). Average family sizes of landlords, landless labourers and others are 5.56, 4.53 and 3.43, respectively, while the average family size of the village as a whole is 5.07. Table 5 gives the demographic details of Berka Alimuddin. The village has a 90 per cent Muslim population and 10 per cent Harijan families.

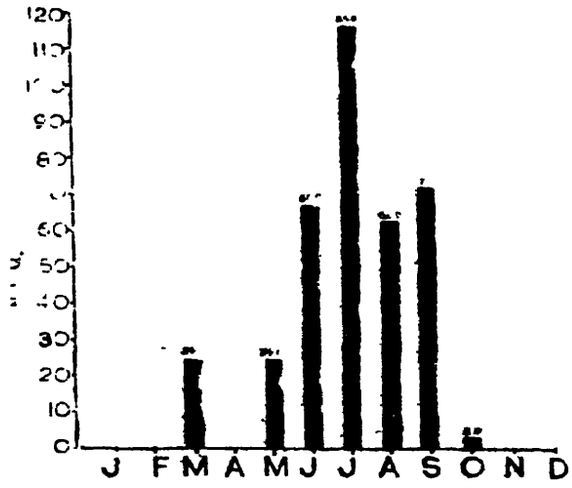
Fig. 4 METEOROLOGICAL DIAGRAM OF 1980

DISTT GURGAON BLOCK – NUH

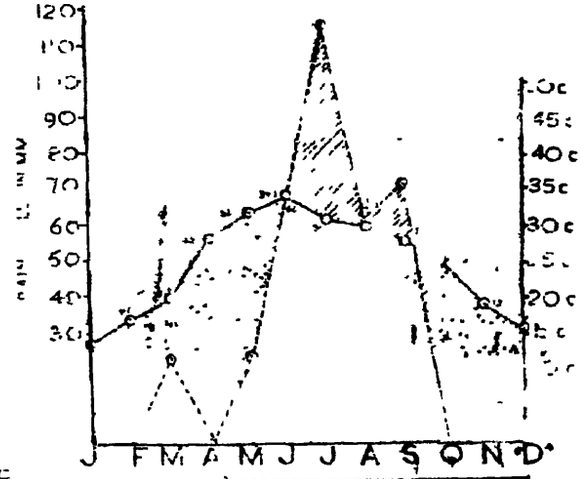
MEAN RELATIVE HUMIDITY DIAGRAM



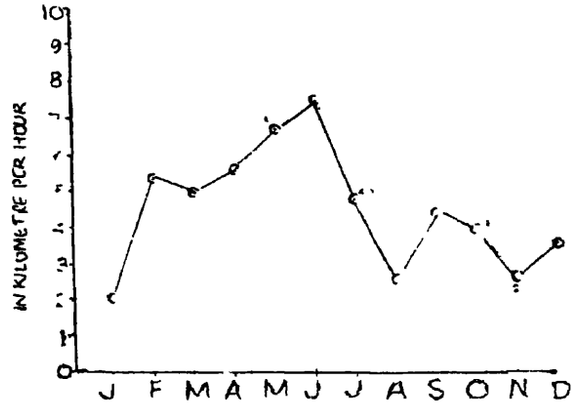
PRECIPITATION DIAGRAM



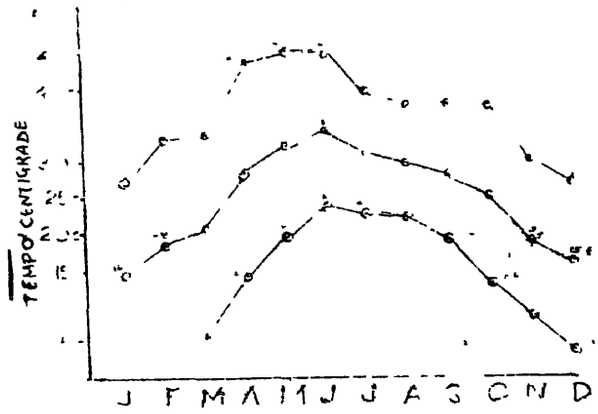
OMBROTHERMIC DIAGRAM



MEAN WIND VILOCITY DIAGRAM



MAXIMUM & MINIMUM TEMPERATURE



REFERENCE

1 DRY MONTH	
2 WET MONTH	
3 MEAN	
4 MAX	
5 MIN	

DRAWN BY GOBIND GARG		
CHKD BY N S NARES	SSO	
APPD BY H M UGUCATI IAS	CPO	

CAO AUTHORITY GURGAON

Village Ecosystem

The total geographical area of the village is 1225.92 acres, out of which 611.24 acres are cultivable land. During the Rabi season of 1985, 524.75 acres of land were cultivated. The crops grown during this period were Wheat, Mustard, Barley and Chana (Chick-pea). The total area under irrigation was 309.25 acres, which indicates that about 50.59 per cent of the agricultural land was irrigated. The area covered under orchards was 30.26 acres. Table 6 gives the complete detail of the land use pattern in the village.

Table 6: Land Use Pattern

Land classification	Area in acres
1. Total village area	1225.92
2. Total cultivable land	611.24
3. Total cultivated land during Rabi Season'85	524.75
4. Fallow land, Rabi Season'85	87.49
5. Home Gardens	30.26
6. Total land under irrigation, Rabi Season'85	309.25
7. Land under tree farming	10.16
8. Panchayat land	9.4
9. Community land (Jumla Malkan)	177.80

Natural Vegetation

The area under forest, the major source of firewood, is 10.16 acres. Natural vegetation is of lesser importance in the surveyed area. The vegetation is scanty, comprising

thinly scattered trees of Acacia nilotica in the low lying areas. Other species are of thorny, hardy and productive-cum-protective type. Table 7 provides the list of common species of trees, bushes and grasses that were observed during the survey.

Table 7: List of Species of Trees in the Village

Sl.No.	Local Name	Botanical Name
1.	Kikar	Acacia nilotica
2.	Babul/Mesquite	Prosopis juliflora
3.	Ber	Zizyphus jubjuba
4.	Neem	Azadirachta nilotica
5.	Sisham	Dalbergia sisso
6.	Sarkanda	Saccharum munja
7.	Dub grass	Cysodon dactylon
8.	Eucalyptus	Eucalyptus hybrid
9.	Siris	Albizia lebbek

Socio-Economic Condition

The majority of the village population consists of small to marginal farmers. Most of the people are poor with a very low standard of living. The methods of cultivation are primitive and so are the implements used.

Cattle Ownership

The distribution of the number of households according to different cattle size range during the Rabi season of 1985

is given in Table 8. It can be noted that as the cattle size increases, the number of households decreases.

Table 8: Distribution of Households According to Cattle Size

Cattle size (Range)	Number of households
Upto 2	59
2 - 4	43
4 - 6	24
6 - 8	13
8 - 10	3
Above 10	3

The distribution of cattle according to land ownership is provided in Table 9. It can be noted that the average cattle size per household decreases as the land ownership decreases. About 79 per cent of the total cattle in the village belong to the landlords. Table 9 also provides the distribution of cattle according to adults and calves in different land ownership categories. Also given in this table are the maximum and minimum number of cattle in each category of household.

Educational Facilities

There is only one school in Berka Alimuddin, which imparts primary education. For high school education the students have to go to village Ghasera, which is situated 9 kms from the village. Distribution of school-going children

Table 9: Distribution of Cattle According to Land Ownership

Type	Land ownership Classification	Cattle particulars				Young				Total			
		Max.	Min.	Average	Total	Max.	Min.	Average	Total	Max.	Min.	Average	Total
I	Large farmer	15	1	5.00	65	7	1	2.23	29	15	1.5	6.15	80
II	Medium farmer	10	1	4.30	99	3	1	1.03	24	11	1.5	4.82	111
III	Small farmer	8	1	3.58	117	4	1	1.05	35	9	1.5	4.09	135
IV	Marginal farmer	6	1	1.74	54	3	1	1.15	36	7	0.5	2.32	72
V	Landless farmer	6	1	1.04	71	4	1	0.50	34	8	1.0	1.29	88
VI	Others	4	1	1.86	12	3	1	1.22	9	5.5	1.0	2.43	17
All Households together		15	1	2.22	389	7	1	1.30	228	15	1.0	2.87	503

Table 11: Distribution of Households According to Land-owned and Land Brought under Cultivation during Rabi Season'85

Land holding Classification (acres)	Land owned			Cultivated land(Rabi'86)			Percent of the total land Cultivated
	Number of households (% of hh)	Av.land per hh (acres)	Total land (acres)	Number of households	Av.land per hh (acres)	Total land (acres)	
Large farmers (> 10)	13 (7.42)	17.92	233.00	10	18.00	180.00	77.25
Medium farmers (5 10)	23 (13.14)	7.96	183.00	21	7.33	154.00	84.15
Small farmers (2.5 5)	33 (18.86)	4.27	141.00	36	4.14	151.00	107.09
Marginal farmers (0 2.5)	31 (17.71)	1.75	54.24	22	1.89	39.75	73.29
All farmers	100 (61.14)	6.11	611.24	89	5.88	524.75	85.85

in the village is given in Table 10, according to land ownership classification.

Table 10: Number of School Going Children According to Land Ownership

Type	Land Ownership Classification	Number of School going Children	
		Total	Average
I	Large farmers	13	1.86
II	Medium farmers	7	1.40
III	Small farmers	13	1.18
IV	Marginal farmers	13	1.44
V	Landless labourer	11	1.22
VI	Others	1	1.00
All households together		58	1.44

Table 10 indicates that the average number of children going to school decreases as the land ownership decreases -- except for the small farmer category where the average figure has gone down to 1.18. It can also be noted that only 58 out of a total of 176 children are going to school which is 32 per cent of the total. Also, it was found that very few girls go to school.

Crop Production Practices in the Village

Most of the farming is done under rainfed conditions and coarse grains are grown, depending on the rainfall patterns. There are two main crop-growing seasons in the

village i.e. Kharif and Rabi. Sorghum (Jowar), Pearl Millet (Bajra), Cluster bean (Guar) and different type of pulses like Mungbean (Mung), Urad and Gingelly (Til) are Kharif crops. Crops grown in the Rabi Season are Wheat, Barley, Mustard and Gram. During the Rabi Season in 1985, 524.75 acres (85.85 per cent) of the total cultivable land was sown. An interesting observation was made with regard to the relation between the category of land owned by the landlords and land utilized for cultivation of different crops. This is given in Table 11. Large, medium and marginal farmers utilized only 77.25, 84.15 and 73.29 per cent respectively, of their total agricultural land for cultivation, whereas the small farmers cultivated more than the land owned by them -- in fact, they took additonal agricultural land on lease from the other farmers.

Wheat was the major crop produced in the village and the area under coverage was 334.75 acres whereas the other three crops i.e. Mustard, Gram and Barley, were cultivated in 89.50, 72.00 and 28.50 acres, respectively. It was found that the yield of each crop category of landlords used their land for cultivation. Also, of the total area under cultivation, only 199 acres (37.99 per cent) was irrigated by using electric pumpsets with an average horse-power of 5.84. Tables 12, 13 and 14 give the production, consumption and distribution of Wheat, Mustard, Gram and Barley crops, respectively, for different categories of cultivated land.

It can be noted from these tables that the percentage of area under irrigation, for each of these crops increases as we move from large farmers to marginal farmers; the productivity or yield per acre also increases correspondingly.

Foodgrain Consumption

Monthly Cereal Consumption

Wheat, Rice, Guar and Bajra are consumed by all the households in the village. Table 16 provides the monthly cereal consumption pattern according to land ownership classification. Table 16 indicates that the per capita total monthly cereal consumption increases as we go down from the large farmers category to that of landless labourer. For large farmers, the per capita consumption is 20.92 kg, whereas for landless labourers, it is more than double i.e. 42.43 kg. Average per capita monthly cereal consumption in the village is 33.73 kg.

Monthly Pulse Consumption

Different types of pulses consumed during the Summer season in 1985 are Chana, Moong, Urad, Masoor and Arhar. The maximum consumption of pulses is in mixed form, followed by Chana (these two comprise nearly 60 per cent of the total pulse consumption in the village), Arhar, Urad, Moong and Masoor. It was found that the average per capita pulse consumption is 3.29 kg per month. Table 17 provides the distribution of monthly pulse consumption according to land ownership classification.

Table 12: Production, Consumption and Distribution of Wheat Crop during Rabi Season'85 According to Cultivated Land Classification

Type	Area cultivated (acres)	Irrigated		Production				Consumption			Sold			Wage			Fodder		
		area	% of total	No. of households	Total (Qtl)	Av/hh (Qtl)	Per acre (Qtl)	No. of households	Total (Qtl)	Av/hh (Qtl)	No. of households	Total (Qtl)	Av/hh (Qtl)	No. of households	Total (Qtl)	Av/hh (Qtl)	No. of households	Total (Qtl)	Av/hh (Qtl)
(1)	(2)	(3)		(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)
A	106	22	22.75	10	510.40	51.04	4.82	9	280.40	31.16	7	206.00	29.43	3	6.00	2.00	4	18.00	4.50
B	88	25	28.41	21	496.80	23.66	5.65	21	350.00	16.67	11	128.00	11.64	2	4.80	2.40	5	14.00	2.80
C	102	28	27.45	36	575.60	15.99	5.64	35	418.00	11.94	14	128.80	9.20	4	7.20	1.80	9	21.60	2.40
D	38.75	19.25	49.68	21	351.20	16.72	9.06	21	257.20	11.97	8	65.60	8.20	4	34.40	1.00	10	4.00	3.44
All classes together	334.75	114.25	34.13	68	1934.00	21.73	6.29	86	347.73	15.06	40	129.45	13.21	13	14.92	1.69	28	13.44	3.14

Table 13: Production, Consumption and Distribution of Mustard Crop during Rabi Season'85 according to Cultivated land classification

Type	Area cultivated (acres)	Irrigated		Production				Consumption			Sold			Wage		
		area	% of total	No. of households	Total (Qtl)	Av/hh (Qtl)	Per acre (Qtl)	No. of households	Total (Qtl)	Av/hh (Qtl)	No. of households	Total (Qtl)	Av/hh (Qtl)	No. of households	Total (Qtl)	Av/hh (Qtl)
(1)	(2)	(3)		(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
A	30	12	40.00	9	68.80	7.64	2.29	0	-	-	9	68.80	7.64	0	-	-
B	27	19	70.37	15	97.60	6.51	3.61	4	23.60	5.90	14	69.20	4.94	2	4.80	2.40
C	31.50	23	73.01	23	127.60	5.55	4.05	3	16.00	5.33	23	104.00	4.52	4	7.60	1.90
D	1	0.75	75.00	1	4.00	4.00	4.00	0	-	-	1	4.00	4.00	0	-	-
All classes together	89.50	54.75	61.17	48	298.00	6.21	3.58	7	39.60	5.66	47	246.00	5.23	6	12.40	2.07

Table 14: Production, Consumption and Distribution of Chara Crop during Rabi Season'85 According to Cultivated Land Classification

Type	Area cultivated (acres)	Irrigated		Production				Consumption			Sold			Wage			Fodder		
		area	% of total	No. of households	Total (Qtl)	Av/hh (Qtl)	Per acre (Qtl)	No. of households	Total (Qtl)	Av/hh (Qtl)	No. of households	Total (Qtl)	Av/hh (Qtl)	No. of households	Total (Qtl)	Av/hh (Qtl)	No. of households	Total (Qtl)	Av/hh (Qtl)
(1)	(2)	(3)		(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)
A	32	7	21.88	8	46.60	5.82	1.46	5	17.60	3.52	4	23.60	5.90	-	-	-	4	5.40	1.35
B	31	12	38.71	15	99.60	6.64	3.21	10	34.80	3.48	10	48.00	4.80	-	-	-	5	14.00	2.80
C	9	3.5	38.88	9	37.80	4.20	4.20	6	14.00	2.33	7	19.40	2.77	-	-	-	2	2.00	1.00
D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
All classes together	72	22.5	31.25	32	184.00	5.75	3.05	21	66.40	3.16	21	91.00	4.33	-	-	-	11	21.40	1.95

Table 15: Production, Consumption and Distribution of Barley Crop during Rabi Season'85 According to Cultivated Land Classification

Type	Area cultivated (acres)	Irrigated		Production				Consumption			Sold			Wage			Fodder		
		area	% of total	No. of households	Total (Qtl)	Av/hh (Qtl)	Per acre (Qtl)	No. of households	Total (Qtl)	Av/hh (Qtl)	No. of households	Total (Qtl)	Av/hh (Qtl)	No. of households	Total (Qtl)	Av/hh (Qtl)	No. of households	Total (Qtl)	Av/hh (Qtl)
(1)	(2)	(3)		(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)
A	12	2	16.67	3	25.60	8.53	2.13	3	9.20	3.07	2	12.00	6.00	-	-	-	2	4.40	2.20
B	8	4	50.00	6	50.00	8.33	6.25	5	20.00	4.00	3	12.00	4.00	-	-	-	4	18.00	4.50
C	8.5	1.5	17.65	9	46.80	5.20	5.51	8	23.20	2.90	6	13.00	2.17	-	-	-	5	10.60	2.12
D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
All classes together	28.50	7.5	26.32	18	112.40	6.80	5.19	16	52.40	3.28	11	37.00	3.37	-	-	-	11	33.00	3.00

Table 16: Distribution of Monthly Cereal consumption pattern According to Land-owned Classification

Type	Monthly Household Cereal Consumption (Kg/month)														
	Wheat			Rice			Guar			Bajra			Total Cereal		
	Total	Av/hh	Per.cap.	Total	Av/hh	Per.cap.	Total	Av/hh	Per.cap.	Total	Av/hh	Per.cap.	Total	Av/hh	Per.cap.
I	1840.02	141.54 (71.59)	16.43	113.49	8.73 (4.69)	1.01	390.00	30.00 (0.00)	3.48	-	-	-	2343.51	180.27	20.92
II	2320.01	100.87 (25.52)	18.13	116.15	5.05 (4.38)	0.91	862.50	37.50 (19.09)	6.74	264.50	11.50 (8.50)	2.07	3563.16	154.92	27.84
III	3309.90	100.30 (34.40)	18.49	509.19	15.43 (56.66)	2.84	1202.85	36.45 (40.20)	6.72	495.00	15.00 (15.00)	2.77	5516.94	167.18	30.82
IV	2459.85	79.35 (34.89)	17.96	198.40	6.40 (5.74)	1.45	1007.50	32.50 (17.85)	7.35	930.00	30.00 (0.00)	6.79	4595.75	148.25	33.55
V	5351.60	78.70 (41.15)	17.38	335.24	4.93 (4.80)	1.09	5100.00	75.00 (45.00)	16.56	2262.76	33.57 (24.31)	7.41	13069.60	192.20	42.43
VI	609.98	87.14 (66.75)	25.42	39.97	5.71 (5.99)	1.67	210.00	30.00 (0.00)	6.75	-	-	-	859.95	122.85	35.83
All classes together	15891.84	90.81	17.90	1312.50	7.50	1.48	8772.93	50.13	9.88	3972.23	25.63	4.47	29949.50	171.14	33.73

Note: Figures within parenthesis indicate Standard Deviation.

Table 17: Distribution of Pulse Consumption Pattern According to Land-owned Classification

Type	Monthly Household Pulse Consumption (Kg/month)																				
	Chana			Moong			Urad			Masoor			Arhar			Mixed			Total Pulse		
	Total	Av/hh	Per.cap.	Total	Av/hh	Per.cap.	Total	Av/hh	Per.cap.	Total	Av/hh	Per.cap.	Total	Av/hh	Per.cap.	Total	Av/hh	Per cap	Total	Av/hh	Per cap.
I	65.00	5.00 (2.51)	0.58	42.25	3.25 (1.79)	0.38	-	-	-	-	-	-	-	-	-	152.75	11.75 (2.05)	1.36	260.00	20.00 (6.15)	2.32
II	63.94	2.78 (1.44)	0.50	41.40	1.80 (0.40)	0.32	-	-	-	17.25	0.75 (0.25)	0.13	-	-	-	320.16	13.92 (2.89)	2.50	442.75	19.25 (4.18)	3.46
III	171.93	5.21 (15.05)	0.96	59.73	1.81 (1.32)	0.33	76.89	2.33 (1.89)	0.43	99.00	3.00 (2.00)	0.55	-	-	-	224.73	6.81 (2.46)	1.26	632.28	19.16 (17.41)	3.53
IV	70.68	2.28 (34.89)	0.52	23.25	0.75 (5.74)	0.17	36.27	1.17 (17.85)	0.26	31.00	1.00 (0.00)	0.23	-	-	-	208.94	6.74 (2.58)	1.53	370.14	11.94 (4.25)	2.70
V	281.52	4.14 (10.89)	0.91	95.20	1.40 (0.49)	0.31	89.76	1.32 (69.77)	0.29	93.84	1.38 (0.41)	0.30	136.00	2.00 (0.00)	0.44	457.64	6.73 (2.80)	1.49	1153.96	16.97 (28.36)	3.74
VI	24.50	3.50 (4.80)	1.02	-	-	-	-	-	-	5.81	0.83 (0.24)	0.24	-	-	-	35.00	5.00 (0.00)	1.46	65.12	9.33 (4.88)	2.72
All classes together	677.35	3.87	0.76	273.00	1.56	0.31	299.28	1.71	0.34	266.06	1.52	0.30	350.00	2.0	0.39	1058.56	6.05	1.19	2924.25	16.71	3.29

Note: Figures within parenthesis indicate Standard Deviation.

Table 18 gives the distribution of total foodgrain consumption according to land ownership classification.

Table 18: Foodgrain Consumption Pattern According to Land Owned Classification

Type	Monthly Household Consumption (Kg/month)		
	Total	Av/hh	Per capita
I	2603.51	200.27	23.24
II	4005.91	174.17	31.30
III	6149.91	186.34	34.35
IV	4965.89	160.19	36.25
V	14223.56	209.17	46.18
VI	925.26	132.18	38.55
All classes together	32873.75	187.85	37.02

The above table indicates that the per capita monthly foodgrain consumption increases from 23.24 kg to 36.25 kg as we move down from large farmers to marginal farmers. On the other hand, the per capita foodgrain consumption is almost double for the households belonging to the landless labourers category, as compared to large farmers. Per capita foodgrain consumption for all the households together is 37.02 kg per month.

Crop Waste Availability and Requirement

Table 19 shows the distribution of the total crop-residue produced in the village according to the category of farmers, using straws to grain ratio for each crop.

The total crop residue produced during the Rabi season of 1985 was found to be 447.80 tonnes. Out of this, 368.35 tonnes (82 per cent) is consumed as fuel for cooking and water heating. About 16.88 tonnes is utilized as fodder feed and the remaining 62.56 tonnes is left in the fields. The distribution of crop residue production, consumption and the quantity left over during the Rabi season of 1985, according to the category of farmers and is presented in Table 20.

Dung Availability and Requirement

Table 21 provides the monthly distribution of total dung production in the village according to the category of farmers and also the consumption of dung either as dungcake or as manure. Out of the 155.82 tonnes of dung collected per month in the village, 28.76 tonnes is consumed as dungcake and 140.18 tonnes as manure. Table 21 shows that 22.64 tonnes of dung per month is purhased by the villagers from outside.

ENERGY USE PATTERNS - MAJOR DOMESTIC AND AGRICULTURAL ACTIVITIES

In this chapter, a detailed analysis of energy use patterns are given. The energy use patterns are represented in the form of an energy balance matrix, which shows the flow of fuel from source to the major domestic and agricultural activities. Different types of energy sources used in the village are:

Table 19: Production of Crop Residue by Category of Farmers during Rabi Season'1985

Type	Wheat Crop			Barley Crop			Mustard Crop			Chana Crop			Total Production of Crop-residues (quintal)
	Grain Production (quintal)	Straw to* Grain ratio	Crop-residue Production (quintal)	Grain Production (quintal)	Straw to* Grain ratio	Crop-residue Production (quintal)	Grain Production (quintal)	Straw to* Grain ratio	Crop-residue Production (quintal)	Grain Production (quintal)	Straw to* Grain ratio	Crop-residue Production (quintal)	
A	510.40	1.48	755.39	25.60	1.58	40.45	68.80	3.55	244.24	46.60	1.98	92.27	1132.35
B	496.80	1.48	735.26	50.00	1.58	79.00	97.60	3.55	346.48	99.60	1.98	197.21	1357.95
C	575.60	1.48	851.69	46.80	1.58	73.94	127.60	3.55	452.98	37.80	1.98	74.84	1453.65
D	351.20	1.48	519.78	-	-	-	4.00	3.55	14.20	-	-	-	533.99
All Households together	1934.00	1.48	2862.32	122.40	1.58	193.39	298.00	3.55	1057.90	184.00	1.98	364.32	4477.93

* Straw to Grain ratio - ICAR: Indian Council of Agricultural Research (1977: 58-77)

Table 20: Distribution of Crop-residue Production, Consumption and Left Over during Rabi Season'85 by Category of Farmers

Type	Crop-residue Production (tonnes) (1)	Crop-residue used as fuel (tonnes) (2)	Crop-residue used as cattle feed (tonnes) (3)	Crop-residue surplus (1)-[(2)+(3)]
I	113.23	9.71 x 5 = 48.55	2.80	61.88
II	135.80	3.91 x 5 = 19.55	4.60	111.65
III	145.36	13.33 x 5 = 66.65	3.42	75.29
IV	53.40	6.20 x 5 = 31.00	0.40	22.00
V	-	39.90 x 5 =199.50	5.63	-205.13
VI	-	0.62 x 5 =368.35	16.88	62.56
All Households together	447.79	73.67 x 5 =368.35	16.88	62.56

Table 21: Monthly Distribution of Cowdung Particulars According to Land-owned Classification

Type	Total number of cattle	Total Dung collected (quintal) (A)	Dung produced per cattle	Dung produced per household	Total quantity of dungcakes made (quintal) (B)	Average weight of a dry dung cake (Kg)	Total Dung cake consumed (quintal)	Dungcake saved for Bitola (quintal)	Dung consumption as manure (quintal) Rabi Season'85	Dung consumption as manure (quintal) Monthly (C)	Dung as Surplus (quintal) (A)-[(B)+(C)]
I	80	203.10 (8.17)	2.54	15.62	63.27 (3.01)	0.73 (0.19)	42.30 (1.93)	20.97 (2.25)	1312.00 (47.18)	328.00	-188.17
II	111	363.90 (13.28)	3.28	16.54	74.73 (2.28)	0.61 (0.17)	53.37 (1.37)	21.36 (1.05)	1535.00 (56.54)	383.75	-94.58
III	135	439.20 (8.06)	3.25	13.73	111.05 (2.12)	0.67 (0.18)	81.65 (1.29)	29.40 (0.81)	1666.20 (30.12)	416.55	-89.40
IV	72	245.25 (6.18)	3.41	9.43	57.32 (1.53)	0.68 (0.17)	45.37 (1.11)	11.95 (0.55)	1094.00 (32.77)	273.50	-85.57
V	88	264.10 (5.37)	3.00	6.14	67.67 (0.91)	0.63 (0.18)	57.77 (0.74)	9.90 (0.38)	-	-	+196.43
VI	17	42.60 (2.59)	2.51	6.09	8.72 (0.67)	0.56 (0.21)	7.11 (0.65)	1.61 (0.03)	-	-	+33.86
All classes together		1558.15	3.03	12.34	382.76	0.65	287.57	95.19	5607.20	1401.80	-226.41

* Bitola is a thatched small hut for storing dungcakes.

Note : Figures within parenthesis indicate standard deviation.

A. Biomass Energy:

Dungcake
Firewood : logs
twigs
Crop-residue

B. Non-Biomass Energy:

Kerosene
Electricity
Diesel
Coal

C. Animal Energy

The end-uses which are considered in:

Domestic Sector

- Cooking
- Lighting
- Water heating
- Blacksmithy

Agriculture Sector

- Land Preparation
- Irrigation
- Application of Inorganic fertilizer (only Urea)
- Application of Organic manure (Cow dung)
- Threshing

Data on total energy consumption for agricultural activities was collected for the entire Rabi season (October-March) 1985. However, for the household activities, energy consumption figures were collected for one month i.e., July, 1985. Thus, to bring consistency in the flow of source-wise total monthly energy consumption vis-a-vis domestic and agricultural activities, the total energy consumption figures for the agricultural activities were calculated for one month only.

Table 22 gives the gross mix of monthly energy consumption for the above listed domestic and agricultural end-uses. The matrix form of representation gives all the detailed cross-flows and allows for the comparison of fuel and end-use in energy terms. All the units are given in 10^6 kCal.

Thus, the gross monthly energy consumption in the village for major domestic and agricultural activities is 780.44 x 10^6 kcal. It can be noted that nearly 96 per cent (i.e. 754.07 x 10^6 kcal) of energy is required to meet household activities. Also, the ratio of biomass: non-biomass : animate energy sources for household and agricultural activities are 20.31 : 1 : 0 and 0 : 1: 2.65, respectively. This indicates that 95.31 per cent of the gross energy consumption in household activities is from biomass and the rest is from non-biomass sources. On the other hand, 72.61 per cent of the energy required for different agricultural inputs is obtained from animate power and the rest is from non-biomass sources.

Table 23 has been expressed as the percentage distribution of sourcewise gross energy consumption for various domestic and agricultural activities. It may be noted that the mix of biomass : non-biomass for household activities is 95.31 : 4.69. Whereas, for agricultural activities, the mix of non-biomass : animal power is 27.39 : 72.61. Also, of the gross energy consumption in the village,

Table 22: Gross Energy Requirement Matrix for the Village Berka Alimuddin (10^6 kCal/month)

	DOMESTIC ACTIVITIES					AGRICULTURAL ACTIVITIES						
	Cooking	Lighting	Water-heating	Black-smithy	All household activities	Land preparation	Irrigation	Urea application	Manure application	Threshing	All agricultural activities	Total
A. BIOMASS												
1. Dungcake	66.37	-	20.64	-	87.01	-	-	-	-	-	-	87.01
2. Firewood:logs	113.55	-	65.60	-	179.15	-	-	-	-	-	-	179.15
3. Firewood:twigs	134.79	-	59.88	-	194.67	-	-	-	-	-	-	194.67
4. Crop-residue	152.71	-	105.15	-	257.86	-	-	-	-	-	-	257.86
All Biomass	467.42	-	251.27	-	718.69	-	-	-	-	-	-	718.69
B. NON-BIOMASS												
5. Kerosene	8.73	6.36	-	-	15.09	-	-	-	-	-	-	15.09
6. Electricity	-	18.76	-	-	18.76	-	3.54	-	-	0.66	4.19	21.79
7. Diesel	-	-	-	-	-	2.82	-	0.20	-	-	3.03	3.03
8. Coal	-	-	-	1.53	1.53	-	-	-	-	-	-	1.53
All Non-biomass	8.73	25.12	-	1.53	35.38	2.82	3.54	0.20	-	0.66	7.22	41.95
C. ANIMAL ENERGY	-	-	-	-	-	18.63	-	0.37	0.15	-	19.15	19.80
All together (A+B+C)	476.15	25.12	251.27	1.53	754.07	21.45	3.54	0.57	0.15	0.66	26.37	780.44

Table 23: Gross Energy Requirement Matrix for the Village Berka Alimuddin (Percentage Distribution)

	DOMESTIC ACTIVITIES					AGRICULTURAL ACTIVITIES						
	Cooking	Lighting	Water-heating	Black-smithy	All household activities	Land pre-paration	Irriga-tion	Urea appli-cation	Manure appli-cation	Threshing	All agri-cultural activities	Total
A. BIOMASS												
1.Dungcake	13.94	-	8.21	-	11.54	-	-	-	-	-	-	11.15
2.Firewood:logs	23.85	-	26.11	-	23.76	-	-	-	-	-	-	22.96
3.Firewood:twigs	28.31	-	23.83	-	25.81	-	-	-	-	-	-	24.94
4.Crop-residue	32.07	-	41.85	-	34.20	-	-	-	-	-	-	33.04
All Biomass	98.17	-	100.00	-	95.31	-	-	-	-	-	-	92.09
B. NON-BIOMASS												
5.Kerosene	1.83	25.30	-	-	2.00	-	-	-	-	-	-	1.93
6.Electricity	-	74.70	-	-	2.49	-	100.00	-	-	100.00	15.90	2.79
7.Diesel	-	-	-	-	-	13.17	-	35.22	-	-	11.48	0.39
8.Coal	-	-	-	100.00	0.20	-	-	-	-	-	-	0.20
All Non-biomass	1.83	100.00	-	-	4.69	13.17	100.00	35.22	-	-	27.39	5.33
C. ANIMAL ENERGY	-	-	-	-	-	86.63	-	64.78	100.00	-	72.61	2.53
All together (A+B+C)	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

92.09 per cent of the energy requirement is met by biomass, 5.38 by non-biomass and 2.53 by animal power.

Energy Consumption Pattern in Households

The distribution of land in terms of size is a major determinant of energy use. Therefore, energy consumption patterns in households have been studied as a function of the land ownership classification. In this section, we have estimated monthly household energy consumption.

Household Classification According to Land Ownership

The land holdings are divided into six classes. The first four are those of landlords with different land ownerships. The fifth group is mainly comprised of landless labourers and the last is a clubbing together of households other than these two categories. Table 24 gives the distribution of land in each category of households.

Table 24 shows that 57.14 per cent of the households are landowners, 38.86 per cent landless labourers and the remaining 4.00 per cent belongs to the others category, which includes a shopkeeper, a tailor, a school teacher, two blacksmiths and two potters.

The next section gives a detailed account of the gross energy consumption pattern in major domestic activities for different land holding sizes as illustrated in Table 24.

Table 24: Distribution of Households According to Land Ownership

Type	Household category According to land ownership	Land owned classification(acres)	Number of households (numbers)	Per cent of households	Total land owned (acres)
I	Large farmer	Over 10	13	7.42	233.00
II	Medium farmer	5 - 10	23	13.14	183.00
III	Small farmer	2.5 - 5	33	18.86	141.00
IV	Marginal farmer	Upto 2.5	31	17.71	54.24
V	Landless labour	-	68	38.86	-
	All classes together	-	175	100.00	611.24

* include one shopowner, one tailor, one school teacher, two blacksmiths and two potters.

Energy Consumption Pattern for Major Domestic Activities

Energy is required for the three major household activities, viz. cooking, lighting and water heating.

(i) Cooking

It was found that five types of fuels are consumed for cooking purposes. These are mostly used in the form of a mix such as dungcake, firewood ; logs, firewood ; twigs, crop-residue and a very insignificant amount of kerosene. The traditional mud stoves (chulhas) used for cooking have an efficiency of the range of 5 to 10 per cent with either firewood or dung. Very few households use kerosene oil for cooking. Table 25 provides the mix of household energy consumption according to different household categories. We have estimated the average consumption per household and also the per capita consumption for different types of fuels in each category.

(ii) Lighting

Though the village is electrified, nearly 22% of the land owning, i.e. 22 households have electric connections in their households. Almost all the households use kerosene for lighting. Table 26 shows the consumption of electricity and kerosene to meet the lighting requirement of different households categories.

Table 25: Monthly Household Energy Consumption Pattern for Cooking According to Land Ownership Classification (Original Units)

Type	Dungcake(Kg)		Firewood: Logs(Kg)		Firewood: twigs(Kg)		Crop-residue(Kg)		Kerosene(litres)	
	Av/hh	Per.cap.	Av/hh	Per.cap.	Av/hh	Per.cap.	Av/hh	Per.cap.	Av/hh	Per.cap.
I	311.54 (166.00)	36.16	420.00 (460.38)	15.00	684.00 (158.70)	30.54	597.00 (896.54)	53.30	10.00 (0.00)	0.09
II	221.32 (26.76)	38.04	160.00 (70.71)	11.25	127.69 (62.78)	12.97	116.76 (63.91)	15.51	-	-
III	242.72 (153.29)	43.39	135.94 (100.45)	15.10	182.86 (70.41)	21.45	149.06 (110.45)	13.32	5.00 (0.00)	0.03
IV	170.65 (117.88)	32.39	107.89 (100.45)	14.96	104.44 (70.41)	20.56	170.00 (110.45)	3.72	5.00 (0.00)	0.04
V	125.33 (73.32)	17.50	93.75 (35.87)	8.52	99.08 (42.52)	19.30	332.00 (305.77)	5.39	-	-
VI	91.50 (59.62)	26.69	80.00 (50.99)	10.00	120.00 (24.49)	15.00	60.00 (0.00)	5.00	-	-
All classes together	180.59	29.47	136.60	11.30	163.88	19.76	249.32	11.46	5.64	0.04

Note: Figures within parentheses indicate standard deviation.

Table 26: Monthly Household Energy Consumption Pattern for Lighting According to Land Ownership Classification (Original Units)

Type	Electricity (KWH)		Kerosene (Litres)	
	Av/hh	Per.cap.	Av/hh	Per.cap.
I	60.00 (30.00)	1.07	4.46	0.52
II	40.00 (25.23)	0.82	4.43 (0.07)	0.80
III	30.00 (18.32)	0.53	4.26 (1.08)	0.74
IV	22.00 (12.36)	0.34	4.29 (1.46)	0.97
V	-	-	4.16 (1.59)	0.84
VI	38.43	-	4.00 (0.76)	1.17
All classes together	34.03	0.60	4.25	0.83

Note: Figures within parentheses indicate standard deviation.

Average consumption of electricity and kerosene in the village is 34.03 kWh and 4.25 litres per month respectively for lighting. It may also be observed that there is no electricity connection in the landless household. Also, a consistent trend can be observed in the consumption of both the fuels as we move from one household category to the next.

(iii) Water Heating

The traditional chulha is used for heating water. The fuel mix generally used for water heating in households is dungcake, firewood; logs, firewood; twigs and crop residue.

The monthly household energy consumption pattern for water heating according to land ownership classification is presented in Table 27.

(iv) Total Energy Consumption for Various Domestic Activities

Tables 25, 26 and 27 respectively, illustrate the gross monthly energy consumption pattern in original units for cooking, lighting and water heating according to land ownership classification. Table 28 has been computed out of these three tables and gives the average total energy consumption or per capita total energy consumption by user population only for cooking, lighting and water heating according to land ownership classification in the village. All the units are given in 10^6 kCal. From Table 28, no conclusion could be drawn about the trend in energy consumption of different end-uses as we move from one category to another.

Households Energy Consumption Pattern

Table 29 presents the gross monthly household energy consumption pattern according to land ownership classification. Monthly per capita requirement of dungcake was found to be 32.46 kg; for logs, twigs and crop residue the figures are 14.17, 21.88 and 14.93 kg. For kerosene, which is mainly used for lighting, the per capita monthly requirement is 0.85 litres, whereas for electricity, which is used only for lighting in the household activities, it is 0.60 kWh.

ble 27: Monthly Household Energy Consumption Pattern for Water Heating According to Land Ownership Classification (Original Units)

pe	Dung cake(Kg)		Firewood: Logs(Kg)		Firewood: Twigs(Kg)		Crop-residue(Kg)	
	Av/hh	Per.cap.	Av/hh	Per.cap.	Av/hh	Per.cap.	Av/hh	Per.cap.
	87.60 (42.49)	3.91	120.00 (42.43)	3.21	300.00 (0.00)	2.68	150.00 (106.77)	4.02
	105.00 (44.50)	4.10	68.33 (58.64)	1.60	30.00 (0.00)	0.70	53.33 (26.21)	1.25
I	84.00 (65.23)	4.22	69.38 (49.15)	3.10	80.00 (98.99)	2.68	255.00 (372.59)	5.70
	38.25 (22.18)	1.68	75.00 (49.75)	2.19	60.00 (30.00)	1.75	30.00 (0.00)	0.58
	27.88 (7.03)	0.72	73.75 (46.35)	1.92	47.50 (24.42)	1.54	240.00 (210.00)	1.56
	60.00 (0.00)	2.50	150.00 (0.00)	6.26	60.00 (0.00)	2.50	-	-
l asses gether	56.16	2.30	78.92	2.42	72.80	1.80	171.68	2.34

te: 1. Figures within parenthesis indicate standard deviation (S.D.)

2. Wherever S.D. is zero it means either one household is using the fuel or all the households who are using these fuels have no variation in fuel consumption.

Table 28: Monthly Household Energy Consumption According to End-use Versus Land-owned Classification(10^6 kCal)

Type	Cooking		Lighting		Water heating	
	Av/hh	Per.cap.	Av/hh	Per.cap.	Av/hh	Per.cap.
I	8.0390	0.4780	0.0898	0.0054	2.6890	0.0501
II	2.2336	0.2486	0.0379	0.0068	0.8727	0.0239
III	2.5793	0.3105	0.0364	0.0063	1.7745	0.0561
IV	1.9994	0.2492	0.0625	0.0087	0.8236	0.0242
V	2.3362	0.1868	0.1905	0.0077	1.4721	0.0233
VI	1.3462	0.1915	0.0342	0.0100	1.1205	0.0467
All	2.7101	0.2499	0.1390	0.0098	1.4258	0.0390

Table 29: Monthly Household Energy Consumption Pattern According to Land Ownership Classification (Original Units)

Type	Dungcake(Kg)		Firewood: Logs(Kg)		Firewood: Twigs(Kg)		Crop-residue(Kg)		Kerosene(litres)		Electricity(KWH)	
	Av/hh	Per.cap.	Av/hh	Per.cap.	Av/hh	Per.cap.	Av/hh	Per.cap.	Av/hh	Per.cap.	Av/hh	Per.cap.
I	399.14	40.07	540.00	18.21	984.00	33.21	747.00	57.32	14.46	0.61	60.00	1.07
II	326.32	42.14	228.33	12.85	157.69	13.67	170.09	16.76	4.43	0.80	40.00	0.82
III	326.72	47.61	205.32	16.20	262.86	24.13	404.06	19.02	9.26	0.76	30.00	0.53
IV	208.90	37.91	182.89	19.01	164.44	24.09	200.00	11.17	9.29	1.01	22.00	0.34
V	153.20	18.22	167.50	10.44	146.58	20.84	572.00	6.95	4.16	0.84	-	-
VI	151.50	29.19	230.00	16.25	180.00	17.50	60.00	5.00	4.00	1.17	-	-
All classes together	236.74	32.46	215.52	14.17	236.68	21.88	421.00	14.93	6.82	0.85	38.43	0.60

To understand the relative fuel value of different energy sources used for household activities, the original units in Table 29 has been converted into their equivalent calorific values i.e., in 10^6 kCal and are presented in Table 30.

Energy Use Patterns in Agriculture

Energy use in agriculture is determined by the different categories of farmers and the size of land used for cultivation during the Rabi season of 1985 (October-March). The energy consumption figures in agriculture are worked out for the entire Rabi season.

Household Classification According to Land Used for Cultivation

Out of a total of 175 households in the village, 100 were landowners; among them, only 89 were engaged in agricultural activities. Thus, the energy consumption pattern in agriculture has been studied for these 89 households by four major categories, as shown in Table 31.

The following section gives in detail the energy consumption pattern for farm operations as well as energy inputs (through organic and inorganic fertilizers, tractor and bullock operated farming, electric pumpsets for irrigation and also post harvest threshing operations using electric threshers).

Table 30: Monthly Household Energy Consumption Pattern According to Land Ownership Classification (10^6 kCal)

Type	Dungcake		Firewood: Logs		Firewood: Twigs		Crop-residue		Kerosene		Electricity		Biomass		Non-Biomass		All fuel	
	Av/hh	Per.cap.	Av/hh	Per.cap.	Av/hh	Per.cap.	Av/hh	Per.cap.	Av/hh	Per.cap.	Av/hh	Per.cap.	Av/hh	Per.cap.	Av/hh	Per.cap.	Av/hh	Per.cap.
I	0.8382	0.0841	2.5650	0.0865	4.6248	0.1561	2.1645	0.2008	0.1291	0.0054	0.0517	0.0009	10.6425	0.5273	0.1808	0.0063	10.2833	0.5336
II	0.6853	0.0885	1.0846	0.0610	0.7411	0.0642	0.5953	0.0587	0.0393	0.0071	0.0345	0.0007	3.1063	0.2724	0.0395	0.0071	3.1458	0.2795
III	0.6851	0.1000	0.9753	0.0770	1.2354	0.1134	1.4142	0.0666	0.0827	0.0068	0.0259	0.0005	4.3110	0.3570	0.0827	0.0068	4.3937	0.3638
IV	0.4387	0.0796	0.8587	0.0903	0.7729	0.1132	0.7000	0.0391	0.0829	0.0090	0.0190	0.0003	2.7803	0.3222	0.1087	0.0094	2.8890	0.3316
V	0.3217	0.0383	0.7956	0.0496	0.6889	0.0979	2.0020	0.0243	0.0371	0.0075	-	-	3.8082	0.2101	0.1921	0.0080	4.0003	0.2181
VI	0.3182	0.0613	1.0925	0.0772	0.8460	0.0823	0.2100	0.0175	0.0357	0.0104	-	-	2.4667	0.2383	0.0357	0.0104	2.5024	0.2487
All	0.4972	0.0682	1.0237	0.0673	1.1124	0.1028	1.4735	0.0523	0.0609	0.0076	0.0331	0.0005	4.1068	0.2906	0.1681	0.0008	4.2749	0.2914

Table 31: Distribution of Households According to Land under Cultivation

Type	Household category According to land under cultivation	Cultivated land Classification (acres)	Number of households (numbers)	Per cent of house-holds	Total land under Cultivation (acres)
A	Large Farmer	Over 10	10	11.24	180.00
B	Medium Farmer	5-10	21	23.60	154.00
C	Small Farmer	2.5- 5	36	40.45	151.00
D	Marginal Farmer	Upto 2.5	22	24.71	39.75
All classes together			89	100.00	524.75

Table 32: Area, Production and Average Yield of Four Major Crops Grown during Rabi season '85 on Various Catagories of Farms

Crop		FARMERS				
		Large	Medium	Small	Marginal	Total
1. Wheat	Area sown (acres)	106	88	102	38.75	334.75
	Area irrigated(acres)	22	25	28	19.25	114.25
	Production (quintal)	510.40	496.80	575.60	351.20	1934.00
	Yield (quintal/acare)	4.82	5.65	5.64	9.06	6.29
2. Barley	Area Sown (acres)	12	8	8.50	-	28.50
	Area irrigated(acres)	2	4	1.50	-	7.50
	Production (quintal)	25.60	50.00	46.80	-	112.40
	Yield (quintal/acre)	2.13	6.25	5.51	-	5.19
3. Mustard	Area sown (acres)	30	27	31.50	1.00	89.50
	Area irrigated(acres)	12	19	23	0.75	54.75
	Production (quintal)	68.80	97.60	127.60	4.00	298.00
	Yield (quintal/acres)	2.29	3.61	4.05	4.00	3.58
4. Chana	Area sown (acres)	32	31	9	-	72.00
	Area irrigated(acres)	7	12	3.50	-	22.50
	Production (quintal)	46.60	99.60	37.80	-	184.00
	Yield (quintal/acres)	1.46	3.21	4.20	-	3.05

Resource assessment of the village ecosystem for carrying out the above mentioned activities has been made for the entire Rabi Season of 1985. As illustrated in Tables 12 13, 14 and 15, there were four major crops grown, viz. wheat, barley, mustard and chana. Area, production and yield of these crops are tabulated in Table 32.

An in-depth study of this table reveals that the average productivity was higher for small and marginal farmers, probably because smaller farms were better managed as compared to large farms which have less input resources per acre.

Energy Requirement for Crop Production

Five major agricultural activities have been studied for the total crop produced in the village during the Rabi season of 1985. These activities are;

- Land preparation
- Application of organic and inorganic fertilizers
- Irrigation, and
- Threshing of the harvested crops.

The energy resources utilized in crop production by different categories of farmers are described in detail below.

(i) Land Preparation and Energy Utilization

Land is prepared in the village by either bullocks or tractors. Total land prepared for

cultivation during the Rabi season was 524.75 acres; 80.18 per cent of the land was prepared by using animal power and the rest by using heavy tractors having an average horse-power of 50. Table 33 provides the distribution of land area cultivated, number of households, number of animal hours utilized and diesel required by tractors according to cultivated land classification.

It can be noted from the above table that small and marginal farmers prepared most of their land using animal power, whereas the large and medium farmers used tractors for the purpose (about 96 animal hours per acre are required to prepare land during the Rabi season and, on an average, 15.36 litres of diesel if a tractor is used).

(ii) Application of Urea (Inorganic Fertilizer) as Energy Input

Nearly 42 per cent of the landowners in the village use inorganic fertilizer. In 35.40 per cent of the total cultivated land (524.75 acres), urea was applied by using either animals or tractors. Table 34 gives in detail the distribution of area under urea application, animal energy utilized and diesel consumption by tractors among different categories of farmers.

Table 33: Energy Consumption during Rabi Season's 1985 for Land Preparation According to Cultivated Land Classification

	Animal Power				Tractor Power				
Type	No.of Households	Area under land preparation(acres)	Total amimal hours	Animal hours per acre	No.of households	Area under land preparation(acres)	Average HP	Total diesel consumption (litres)	Diesel consumption per acre (litres/acre)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
A	8	116	6146	52.98	2	64	50	974.00	15.22
B	18	130	8660	66.62	3	24	50	359.00	14.96
C	33	141	18181	128.94	2	8	50	120.00	15.00
D	12	33.75	7504	223.34	5	7	50	129.00	18.43
All classes together	7	420.75	40491	96.32	12	103	50	1582.00	15.36

Table 3.4: Energy Consumption during Rabi Season's 1985 for Application of Inorganic Fertilizers (Urea) According to Cultivated Land Classification

	Animal Power				Tractor Power				
Type	No. of household	Area under application	Total animal hrs.	Animal hrs. Per acre	No. of household	Area Under application	Average HP	Total diesel consumption (litres)	Diesel consumption per acre (litre/acre)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
A	3	43	124	2.88	-	-	-	-	-
B	10	66	234	3.55	2	12	50	76	6.33
C	13	53	322	6.08	2	9	50	38	4.22
D	11	23.75	134	5.64	-	-	-	-	-
All classes together	37	185.75	814	4.38	4	21	50	114	5.43

It can be observed that average animal hours required per acre -- if all farming categories are considered together -- is 4.38, whereas diesel consumption per acre by a tractor of 50 horse-power for urea application is 5.43 litres. Also, tractors were not used by large and marginal farmers for urea application.

(iii) Application of Cow dung as Manure and Energy Input

Almost 90 per cent of the farmers applied cow dung as manure; 95 per cent of the total cultivated area of 524.75 acres was covered. Table 35 gives the distribution of animal energy utilized for this activity by the different category of farmers.

On an average, all households together required 0.63 animal hours per acre for applying manure.

(iv) Irrigation and Energy Use

Out of the total cultivated area of 524.75 acres, 309.25 acres (64.35 per cent) was irrigated. Electric pumpsets were the only implements used for irrigation. No diesel pumpsets were used for irrigation in the village. During the Rabi season of 1985, only 19 electric pumpsets were used, though almost 50 per cent of the farmers irrigated their fields. The average horse power of these pumpsets varied between 7.36 to 5.00. Average electricity consumption for irrigating one acre of cropped land was estimated to be 66.39 kWh.

Table 35: Energy Consumption during Rabi season'1985 for Application of Organic Manures (Cow dung) According to Cultivated Land Classification

Type	No. of households	Area under application	Total animal hours	Animal hours per acre
A	10	180	127.80	0.71
B	20	147	95.55	0.65
C	33	138	59.34	0.43
D	17	32.75	32.75	1.00
All classes together	80	497.75	315.44	0.63

Table 36 provides in detail the distribution of electricity consumption by pumpsets for different categories of farmers.

It can be observed that average electricity consumed per acre per pumpset of irrigated area increases from 3.32 kWh to 10.95 kWh -- more than three times -- as we move down from the large farmers to the marginal farmers category.

(v) Threshing and Energy Use

A major energy-intensive agricultural operation, i.e., threshing by using electric threshers, was also considered in the study. The total number of electric threshers used in the village was 21. Table 37 gives the distribution of electricity consumption by threshers according to categories of farmers.

The average electricity consumed by threshers considering all categories of farmers together was 57.86 kWh. It can also be found that electricity consumption decreases from 112.86 kWh to 42.50 kWh, almost six times as we move down from the large farmers category to the marginal farmers.

Energy Consumption Patterns in Agriculture

To understand the relative energy consumption pattern for different agricultural operations, viz. land preparation,

Table 36 : Electricity Consumption by Pumpsets during Rabi season'1985 for Irrigation According to Cultivated Land Classification

Type	No. of households irrigating through Pumpsets	Irrigated area	Irrigated % of total	No.of pumpsets* Own	No.of pumpsets* Hired	Total hours used	Average HP	Total electricity consumption (kWH)	Electricity consumption per acre per pumpset (kWH/acre/pumpset)
A	6	125	34.40	5	1	500	7.00	2490	3.32
B	14	107	56.07	7	8	1691	5.00	9105	5.67
C	14	56	100.00	3	11	1438	5.00	6376	8.13
D	11	21.25	94.12	4	7	1096	7.36	2560	10.95
All classes together	45	309.25	64.35	19	27	4725	5.84	20531	1.44

Note: Village does not have diesel pumpsets.

Table 37: Electricity Consumption by Electric Threshers after Rabi Season'1985 Harvesting According to Cultivated Land Classification

Type	Number of households having electric threshers	Number of threshers Own	Number of threshers Hired	Hours used Total	Hours used Per household	Total electricity (KWH)	Average electricity consumption per thresher (KWH/thresher)
A	4	4	3	146	20.86	790	112.86
B	4	4	12	200	12.50	884	58.93
C	7	7	20	283	10.48	1465	56.35
D	6	6	10	124.50	7.76	680	42.50
All classes together	21	21	45	753.50	11.42	3819	57.86

application of inorganic fertilizers and organic manures, irrigation and threshing, the original units in Tables 33, 34, 35 36, and 37 have been converted into equivalent calorific values and are presented in Table 38.

It can be noted that animal energy required for one acre of land preparation increases as we move down from the large farmers to the marginal farmers category -- the quantum increase is, in fact, more than four times. The village being economically backward very few tractors were found in the village but these tractors are taken on hire by different category of households if they can afford for land preparation, supplemented with animate energy. And no trend was observed in the case of tractors used for land preparation. Also, electricity consumption by pumpsets used for irrigating one acre of land increases more than six times as we move down from the large farmers to the marginal farmers category the reason being it was found that too much personal care and attention i.e. better farm management practices paid by farmers due to smallness and consolidated holdings. Another trend can be observed in the case of electricity consumption by threshers: it was found that electricity consumption per thresher increases by about three times as we move up from the marginal farmers to the large farmers category.

Table 38: Energy Consumption in Different Agricultural Activities by Different Category of Farmers (10^6 KCal)

Type	Land preparation				Inorganic fertilizer (Urea)				Organic manure (dung)		Irrigation		Threshing	
	Total animal energy	Animal energy per acre	Total diesel by tractor	Diesel per acre by tractor	Total animal energy	Animal energy per acre	Total diesel by tractor	Diesel per acre by tractor	Total animal energy	Animal energy per acre	Total elec. consumed	Elec. consumed per acre	Total elec. consumed	Elec. consumed per thresher
A	14.1358	0.1219	8.6939	0.1359	0.2852	0.0066	-	-	0.2939	0.0016	2.1439	0.0172	0.6802	0.0972
B	19.9180	0.1532	3.2044	0.1335	0.5382	0.0082	0.6784	0.0565	0.2198	0.0015	7.8394	0.0733	0.7611	0.0507
C	41.8163	0.2966	1.0711	1.339	0.7406	0.0140	0.3392	0.0377	0.1365	0.0010	5.4897	0.0980	1.2614	0.0485
D	17.22592	0.5137	1.1515	0.1645	0.3082	0.0130	-	-	0.0753	0.0023	2.2042	0.1037	0.5855	0.0366
All	93.1293	0.2775	14.1209	0.1371	1.8722	0.0101	1.0176	0.0485	0.7255	0.0014	17.6770	0.0572	3.2882	0.0498

ENERGY DEMAND PROJECTIONS

The approach for estimating the future energy requirements in the village households is an analysis of information and data available on energy consumed in different end-uses and changes in population distribution of households. The required data of energy consumption is obtained from the previous section. The growth in population is taken from "Profiles of Districts, July 1985, Part 1, Centre for Monitoring Indian Economy".

Population Projections

The village 'Berka Alimuddin' had a population of 888 in 175 households. The decennial growth rate of population in the Gurgaon district is 28 per cent. We assume that the growth rate is applicable to village Berka Alimuddin and that it will remain the same for the decennials from 1981 to 2001 AD. Then the population of the village in 2001 AD can be calculated as

Population in 2001 AD = $888(1+0.0226)^{16} = 1270$

Assuming the household size to remain the same in 5.07, the number of households in 2001 AD will be about 250.

Energy Demand in the Domestic Sector

Here we consider the three end-uses viz., cooking, lighting and water heating. We assume that the level and pattern of energy consumption will remain the same as in 1985.

(i) Cooking - The annual fuel requirement (fuelwise) for cooking in village Berka Alimuddin in the year 2001 AD can be estimated by using the following formula.

Population in 2001 AD x 12 x (Per capita monthly fuel consumption in physical units during 1985,...(1)

(ii) Water heating - The annual fuel requirement (fuelwise) for water heating in the village in the year 2001 AD can be estimated as

Population in 2001 AD x 4 x (Per capita monthly fuel consumption in physical units during 1985,...(2)

(iii) Lighting - The villagers' main fuel for lighting is kerosene besides some electricity which is also being used. The supply of electricity to the village is very irregular. The annual energy consumption for lighting during 2001 AD can be estimated as

Number of households in 2001 AD x 12 x (Monthly per-household fuel consumption for lighting during 1985 ...(3)

Using the above three formulae (1), (2) and (3), the respective annual fuelwise cooking, water heating and lighting demand for the year 2001 AD is presented in Table 39.

Table 39: Total Energy Requirement for Various Domestic Activities during 2001 AD

Fuel type	Physical unit	Total cooking	Total water heating	Total lighting
		2001 AD	2001 AD	2001 AD
Dungcake	(tonne)	449.12	35.05	-
Firewood: logs	(tonne)	172.21	36.88	-
twigs	(tonne)	301.14	27.43	-
Crop residue	(tonne)	174.65	35.66	-
Kerosene	(litres)	609.60	-	12750
Electricity	(kWh)	-	-	115290

Energy Demand in the Agricultural Sector

In the village Berka Alimuddin, the level of mechanization is rather low, but appears to be picking up, with the villagers acquiring mechanical devices. In the future years, it would be expected that the use of mechanical devices would intensify the yield per acre and effect a higher level of output. Also, the gross area under cultivation would increase. These are the obvious trends of mechanization which are apparent from the level of the yield and the energy consumed per acre in the highly mechanized state of Punjab. In Table 40 given below, the status regarding the level of mechanization, as was found in the year 1985, is summarized. Assumed values regarding the developments that would be in village Berka Alimuddin, are also presented. The end-uses considered for further estimation of energy demand are ploughing and irrigation,

which are the two major energy-intensive agricultural activities.

However, for making projections for energy requirements during the Rabi season, the following developments are assumed to have taken place by 2001 AD.

1. 75 per cent of the village agricultural land is irrigated;
2. 80 per cent of the land preparation is carried out by using tractors;
3. The cropping pattern will remain the same and the area under coverage for each crop will increase proportionately with that of the net cultivable area in the Rabi season;
4. The level of agricultural energy consumption norm will remain the same as it was during 1985.

Table 40: Present and the Future Level of Mechanization during Rabi season

Description	Present Year: 1985	Projected Year: 2001
Net area cultivable (acres)	611.24	611.24
Cropping intensity during Rabi season	0.86	1.00
Net area cultivated (acres)	524.75	611.24
Area tractorized for land preparation (acres)	103.00	488.99
Area irrigated through electric pumpsets (acres)	309.25	463.88

In the section entitled 'Energy Use Patterns in Agriculture', the energy consumption norms had been worked

out on the basis of energy consumed per acre in the agriculture sector. The same norms have been used to estimate the energy requirement for land preparation and irrigation in the year 2001. This is presented in Table 41.

Table 41: Energy Consumption Norms and Estimated Agricultural Energy Demand during Rabi season of 2001 AD

ɛription	Level of Mechanization			Energy Consumption Norms			Total Energy Requirements			
	Unit	Present (1985)	Future (2001)	Unit	Av.Hp	Consumption	Unit	Av. HP	Present (1985)	Future (2001)
ɛtorized a	acre	103.00	468.99	lt/acre	50	15.36	litres	50	1582.08	7510.89
igation* by ɔtric pump- only	acre	309.25	463.88	kWh/acre/ pumpset	5.84	1.44	kWh	5.84	445.32	667.99

, was found that no diesel pumpset was used by the villagers for irrigating their fields. llagers were only using electric pumpsets. Thus it is assumed that during 2001, fields ll be irrigated by using electric pumpsets only.

SUMMARY AND CONCLUSIONS

This report presents the results of a survey carried out during the post-harvesting Rabi season of 1985 (July-August 1985) for the assessment of resource availability and total energy needs of a typical Mohammedan village called Berka Alimuddin located in the Gurgaon district of Haryana.

General information about the village is given in Annexure I. Annexures II and III provides proforma questionnaire: for collecting village and household level information. These questionnaires were prepared to assess the energy needs and to understand the resource potential of the village. The methodology adopted for achieving the objectives (listed under the heading 'Scope of the Study') is described under 'Materials and Methodology'. The section entitled 'General Description of the Area' provides the general description of the village for which data was obtained from the Soil Survey Officer of the Nuh Block, district Gurgaon. The observation of the resource availability and consumption for various activities in the village community have been collected and an analysis of the results are presented in the section on 'Energy Use Patterns - Major Domestic and Agricultural Activities'.

The following are the salient features of village Berka Alimuddin :

1. The village has 175 households with a total population of 888 consisting of 29.62 per cent male adults, 24.10 per

cent female adults, 24.55 per cent male children and 21.73 per cent female children (below 18 years of age).

2. Landless labourers constitute 42.85 per cent, Marginal farmers 17.71 per cent, Small farmers 18.86 per cent, Medium farmers 13.15 per cent, and Large farmers 7.43 per cent of the population.

3. Total cattle population is 617, out of which 63.05 per cent are adults and 36.95 per cent are calves.

4. 7.43 per cent of the households under large farmers own 38.12 per cent of the cultivable land whereas 17 per cent of the households under marginal farmers over 8.87 per cent of the cultivable land.

5. About 32.56 per cent of the total cropped area is under irrigation and the rest is rainfed.

6. The average number of children going to school decreases as the land ownership decreases. Only 32 per cent of the children are going to school.

7. Wheat, Barley, Mustard and Gram are the main Rabi season crops, whereas Kharif season crops are Sorghum, (Jowar), Pearl Millet (Bajra), Cluster bean (Guar) and different types of pulses. Wheat is the major crop produced in the village and the area under coverage was 334.75 acres (63.79 per cent) whereas the other three crops i.e., Mustard, Gram and Barley are 17.06 per cent, 13.72 per

cent and 5.43 per cent, respectively. Also, the average yield of Wheat, Mustard, Gram and Barley per acre are 6.29, 3.58, 3.05 and 5.19 quintals, respectively.

8. Monthly per capita cereal consumption is 33.73 kg whereas for pulses it is 3.29 kg. This indicates that the per capita total foodgrain consumption is 37.02 kg/month.

9. The total crop residue produced during the Rabi season of 1985 is 447.80 tonnes. Out of this, 82 per cent is consumed as fuel and about 4 per cent as fodder and the remaining is left in the fields or is used for thatching purposes.

10. The total dung collected per month is 155.82 tonnes. Out of this, 18.46 per cent is consumed as dungcake and the remaining 81.54 per cent is used as manure.

11. The total energy consumption in the village during July 1985 (Summer season) was 780.44×10^6 kCal with a monthly requirement of biomass = 718.69×10^6 kCal (92.09 per cent), whereas the non-biomass requirement was 41.95×10^6 kCal (5.38 per cent) and animal energy requirement was 19.80×10^6 kCal (2.53 per cent).

Energy Consumption Norm in Household Activities

12. In the households, per capita consumption of firewood: twigs is maximum, followed by -- in order of preference -- dungcake, firewood: logs, crop residue, kerosene and electricity, which is used the least.

13. The mix of total energy consumption for cooking, lighting and water heating is nearly 64 : 3 : 33.

14. Percentage mix of biomass and non-biomass energy sources is nearly 96 : 4. For cooking, lighting and water heating the mix of biomass and non-biomass are 98 : 2, 0 : 100 and 100 : 0, respectively.

15. Two blacksmiths were found in the village, using coal for firing their furnaces. Average coal consumption per month in the village was found out to be 268 kg, equivalent to 1.53×10^6 kCal.

Energy Consumption Norm in Agricultural Activities

16. The energy consumption norm in five major agricultural activities have been studied for the total crop produced in the village during the Rabi season of 1985. These activities are Land preparation, application of organic manures, inorganic fertilizers, irrigation and threshing.

(i) Land Preparation:

The survey reveals that out of the total land cultivated (524.75 acres) during Rabi season 1985, 80.18 per cent of the land was prepared using animal power and the rest by using 50 HP tractor. Average animal hours per acre of land preparation is 96.32 hours whereas 15.36 litres of diesel is consumed by tractors for preparing one acre of land.

(ii) Inorganic Fertilizer (Urea)

Nearly 42 per cent of the land owners in the village use urea in their fields in 35.40 per cent of the total cultivated land.

(iii) Organic Manure (Cow dung)

Almost 90 per cent of the farmers applied cow dung as a manure in 95 per cent of the total cultivated land.

(iv) Irrigation by Electric Pumpsets

The village uses only 19 electric pumpsets with an average H.P. 5.84 irrigation. Very inconsistent result is obtained with respect to electricity consumption for irrigating one acre of land acres different land ownership categories. Electricity consumption by pumpsets in large farmers field is 19.92 kWh/acre. Whereas for the marginal farmer's field is 120.47 kWh/acre about 6 times higher. This high variability may be due to incorrect specification of the data by the respondents.

(v) Threshing by Electricity

The village uses 21 electric threshers. On an average, the electricity consumption per thresher is 57.86 kWh during Rabi'85 post harvest.

The section on 'Energy Demand Projections' presents the energy demand projections of various domestic and agricultural activities for the year 2001 AD.

REFERENCES

1. National Council of Applied Economic Research, New Delhi, "Report on Rural Energy Consumption in Northern India", January 1981.

BIBLIOGRAPHY

1. Ansari, Z.A., "High Intensity Detailed Soil Survey and Land Use Report", Soil Survey Office, Command Area Development Authority, Gurgaon, 1980.

2. Bowonder, B., Rao, N.P., et al "Energy Consumption In Rural Areas of Semi-arid Agro-climatic Regions", Center for Energy, Environment and Technology, Administrative Staff College of India, Hyderabad, 1984.

3. Maheshwari, R.C., Srivastava, P.K., et al "Energy Census and Resource Assessment of Village Islamnagar In the District of Bhopal", Central Institute of Agricultural Engineering, Bhopal, 1981.

4. Economic Intelligence Service, "Profiles of Districts Centre for Monitoring Indian Economy", July 1985.

Annexure I

VILLAGE AT A GLANCE

1.	Village	Berka Alimuddin
2.	Block	Nuh
3.	District	Gurgaon
4.	State	Haryana
5.	Distance of the village from block headquarters	16 kms
6.	Distance of the village from district headquarters	52 kms
7.	Distance of the village from the metalled road	7 kms
8.	Population size	888 (male 481, female 407)
9.	Number of houses	175
10.	Location at:(i) Longitude (ii) Latitude	$27^{o}10'55"$ to $28^{o}12'30"$ (E) $76^{o}59'30"$ to $77^{o}1'20"$ (N)
11.	Number of clusters including the village	3
12.	Major crops grown in the village: (i) Rabi season'85 (ii) Kharif season'85	 Wheat, Barley, Mustard, Chick-pea(Chana) Sorghum (Jowar), Pearl Millet (Bajra), Cluster bean (Guar)
13(i).	Total area under agriculture:	611.24 acres
(ii)	Cultivated land during Rabi Season	524.75 acres
14.	Total number of pumpsets for irrigation: (i) Electric (ii) Diesel	21 nil
15.	Total number of threshers: (i) Electric (ii) Diesel	 19 nil
16.	Total area under irrigation: Rabi Season'85	309.25 acres

Contd.../

Contd.../

17. Total area under tree farming	10.16 acres
18. Cattle population : Rabi season	503
19. Reference period of survey	July-September, 1985

ANNEXURES II & III

QUESTIONNAIRE
(For Rural Energy Survey)

Tata Energy Research Institute
New Delhi, India.

ANNEXURE II

SCHEDULE - I

VILLAGE PARTICULARS

A. IDENTIFICATION :

1. Village .....
2. Block .....
3. District .....
4. State .....
5. Number of households .....
6. Population .....
7. Caste breakup :

Caste	Percentage
.....	.....
.....	.....
.....	.....
.....	.....
.....	.....

8. Located in (Plain/Hilly/Desert) region

B. GENERAL CHARACTERISTICS

1. Distance from the block .....
2. Distance from the main road .....
3. Road connecting the village with the main road (Metalled/Unmetalled)
4. Type of school (Primary/Middle/Secondary)
5. Electrified (Y/N)
6. Irrigation (Y/N)

7. Post office (Y/N)

8. Dispensary/Hospital (Y/N)

9. Veterinary hospital (Y/N)

10. Bank (Y/N)

11. Distance from the nearest bus stand .....

12. Distance from the nearest railway station .....

13. Availability of water hyacinth (Y/N)

C. LAND PARTICULARS

Land Use: (Acres/Hectares)

1. Cultivable .....
2. Forest Land .....
3. Community Land .....
4. Pastures Land .....
5. Barren Land .....
6. Orchard Land .....

Land Distribution: Number of families of

7. Large farmers (greater than 10 acres) .....
8. Medium farmers (between 5 & 10 acres) .....
9. Small farmers (between 2.5 & 5 acres) .....
10. Marginal farmers (below 2.5 acres) .....
11. Landless .....

D. WATER PARTICULARS

Water for Irrigation:

1. Source of water for irrigation: Canal (Y/N) .....

   Well (Y/N) .....

River (Y/N) .....

Tubewell (Y/N) .....

Tank (Y/N) .....

2. Total irrigated area (acres) .....

3. Depth of ground water table ..... in Summer

..... in Winter

Drinking water:		Number
4. Source of drinking water :	Tap (Y/N)	.....
	Well (Y/N)	.....
	Tubewell (Y/N)	.....
	Tank (Y/N)	.....

5. pH value of ground water .....

E. SOIL CHARACTERISTICS

1. Soil texture of cultivated soil .....
2. pH value of soil used for cultivation .....
3. Soil texture of un-cultivated soil .....
4. pH value of soil not used for cultivation .....

F. TREE PARTICULARS

a. Pre-dominant local tree species and its use :

Local name	Botanical name	Use
1.	1.	1. .....
2.	2.	2. .....
3.	3.	3. .....

4.	4.	4. .....
5.	5.	5. .....
6.	6.	6. .....
7.	7.	7. .....

G. CROP PARTICULARS

Crops grown	Season	Average yield (kgs/ hectare
1.	1.	1. .....
2.	2.	2. .....
3.	3.	3. .....
4.	4.	4. .....
5.	5.	5. .....
6.	6.	6. .....
7.	7.	7. .....
8.	8.	8. .....
9.	9.	9. .....
10.	10.	10. .....
11.	11.	11. .....
12.	12.	12. .....

H. TYPE OF ANIMALS

1. Bullocks (Y/N)	6. Camels (Y/N)
2. Cows (Y/N)	7. Horses (Y/N)
3. Buffaloes (Y/N)	8. Sheep (Y/N)
4. Donkeys (Y/N)	9. Pigs (Y/N)
5. Goats (Y/N)	10. Others (specify) (Y/N)

I. ENERGY SOURCE

Traditional energy:

Biomass :

1. Woodfuels (Logs/Twigs/Branches/Charcoal) (Y/N)
2. Agrowastes (All type of crop residues) (Y/N)
3. Animal residue (Animal Droppings) (Y/N)
4. Fuel crops (Crops specially grown for fuel purpose) (Y/N)

Animate :

5. Man power (Y/N)
6. Animal power (Y/N)

Non-traditional energy:

7. Electricity (Y/N)
8. Diesel oil (Y/N)
9. Coal/coke (Y/N)
10. Kerosene (Y/N)
11. Petrol (Y/N)

J. MECHANICALLY DRIVEN EQUIPMENT & MODE OF TRANSPORT

	Number(s)
1. Tractor	.....
2. Diesel pumpset	.....
3. Electric pumpset	.....
4. Thresher	.....
5. Power tiller	.....
6. Others (specify)	.....

K. PRICE DATA

Fuel	Price		Source distance (kms)	Remarks
	Ration shops	Other shops		
1. Kerosene/litre				
2. Diesel/litre				
3. Petrol/litre				
4. Electricity Agriculture/kWh				
5. Electricity domestic/kWh				
6. Charcoal/kg				
7. Coal/kg				
8. Soft coke/kg				
9. Fuelwood(logs)/kg				
10. Fuelwood(twigs)/kg				
11. Dungcakes/ 100 pieces*				

* Weight of a dry dung cake = ... kg

L. TYPE OF ESTABLISHMENTS

Number of:

1. Shops .....
2. Ration shop .....
3. Co-operative .....
4. Others (Specify .....) .....

M. SMALL INDUSTRIES

1.	Flour mill(s)	(Y/N)
2.	Rice mill(s)	(Y/N)
3.	Smithy	(Y/N)
4.	Pottery	(Y/N)
5.	Brick making	(Y/N)
6.	Charcoal making	(Y/N)
7.	Sugarcane processing	(Y/N)
8.	Oil processing	(Y/N)
9.	Furniture shop	(Y/N)
10.	Agricultural implements	(Y/N)
11.	Tobacco curing	(Y/N)
12.	Weaving	(Y/N)
13.	Others (Specify .....)	(Y/N)

N. CHULHAS OR COOKSTOVES PARTICULARS

Type	Used for	Material	Self-made/ purchased	If purchased when & at what price	Portable
1.					
2.					
3.					
4.					

O. NEW AND RENEWABLE ENERGY DEVICES

Awareness	Your Opinion
1. Biogas plant (Y/N)	.....
2. Windmill (Y/N)	.....
3. Solar thermal devices (Y/N)	.....
4. Solar photovoltaic systems (Y/N)	.....
5. Energy plantations (Y/N))	.....
6. Improved wood stoves/chulhas/ cookstoves (Y/N)	.....

P. RENEWABLE RESOURCES DATA

To be obtained from the nearest metereological department for each month :

1. Solar radiation intensity .....
2. Solar radiation distribution .....
3. Hourly wind speed .....
4. Ambient temperature .....
5. Relative humidity .....
6. Rainfall months .....
7. Average annual rainfall .....

Q. INCOME

1. Number of households below poverty line .....
2. Number of households in middle income group .....
3. Number of households in rich income group .....

ANNEXURE III

SCHEDULE - II

(HOUSEHOLD PARTICULARS)

A. IDENTIFICATION

1. Sample household number .....
2. Name of head of household .....
3. Son of .....
4. Village .....
5. Block .....
6. District .....
7. Respondent's name .....
8. Relation with the head of household .....
9. Type of house : Kutcha (Y/N)
   Pucca (Y/N)
   Mixed (Y/N)
10. Family Size .....

B. FAMILY DETAILS

Sl No.	Name	Relation with the head of household	Sex	Age	Educational levels	Occupation

C. LAND HOLDING PARTICULARS

1. Last Cropping Season .....from ..... to .....
   (month) (month)
2. Total land owned by the household .....
3. Total land taken on ..... given on ..... lease
4. Total cropped area .....
5. Total fallow land .....
6. Total uncultivable land .....
7. Total land under pastures/grazing .....
8. Total land under forest .....
9. Total land under orchard .....
10. Net irrigated area .....

D. LIVESTOCK PARTICULARS

Type of animal	Number of animals		Daily Average dung output per animal	
	Young	Adult	Young	Adult
1. Bullocks				
2. Cows				
3. Buffaloes				
4. Donkeys				
5. Goats				
6. Camels				
7. Horses				
8. Sheep				
9. Pigs				
10. Others (Specify)				

11. Amount of dung collected from the field .....

12. For what purpose dung is used :

    i) Dung cakes (Y/N)

    ii) Manures (Y/N)

DUNG CAKES

13. Weight of a freshly made wet dung cake .....

14. Weight of a dry dung cake .....

15. Which are the months, when dung cakes are not made? .....

16. Number of dung cakes made (per day/month) .....

17. Number of daily consumption of dung cakes :

    i) for cooking .....

    ii) for water heating .....

    iii) for any other purpose (Specify) .....

18. Number of dung cakes saved (per day/month) .....

19. Price of a dung cake .....

20. Do you sell dung cakes? (Y/N)

21. If yes, how many per month .....

22. Do you purchase dung cakes? (Y/N)

23. If yes, how many per month .....

Unit Conversion in Kg : .....

DUNG AS MANURE
(For last cropping season only)

24. Amount of dung used as a manure in the field ..... in ..... (acres/hectare)

25. Did you purchase dung for manure from outside? (Y/N)

26. If yes, how much quantity .....

27. At what price? .....

Unit Conversion in Kg : .....

E. PRE-HARVESTING OPERATIONS
(For last cropping season only)

Type of Energy	Human Muscle Power		Tractor		Pumpset		Bullock pairs	
Pre-harvesting Operations	No. Days	No. Persons	Hrs/ day/	No. Days	Av. Hrs/ per-son	No. Days	Av. Hrs/ day	No Da
1. Presowing irrigation								
2. Ploughing & land prep-aration								
3. Manure applications								
4. Transplan-ting								
5. Sowing								
6. Irrigation								
7. Weeding								
8. Fertilizers application								
9. Pesticides application								

10. H.P. of the tractor .....

11. Hourly diesel consumption in the tractor .....

12. Hiring rate of the tractor .....

13. H.P. of the pumpset .....

14. Type of pumpset <u>(electric/diesel)</u>

15. Hourly diesel consumption in diesel pumpset .....

16. Hourly electricity consumption in electric pumpset .....

17. Hiring rate of the pumpset .....

HARVESTING AND POST-HARVESTING OPERATIONS
(For the last cropping season)

Sources of Energy	Human Muscle Power			Tractor		Bullock pairs		Threshers		
Harvesting & post-harvesting operations	Numer of Days	Numer of Persons	Hrs/day person	No. Days	Av. hrs/ day	No. Days	Av. hrs/ day	No. Days	Av. hrs/ day	No.of threshers used
1. Harvesting										
. Threshing										
3. Drying of crop										
4. Processing										
5. Million										
6. Any other (specify)										

7. H.P. of the threshers .....

8. Hiring rate of the thresher .....

9. Type of thresher (Manual/electric/diesel)

10. Hourly diesel consumption (Tractor) ..... (Thresher) .....

11. Hourly electricity consumption (Thresher) .....

. **LABOUR PARTICULARS**
(For the last cropping season only)

Question: If you are a landlord, please answer the following questions.

1. Did you use any labourer? (Y/N)

2. If yes, whether these labourers' belong to the village? (Y/N)

3. If yes, please fill up the following table

Name of the labourer Sex Age Head of the household

4. Total number of labour days in the season .....

5. One labour day equals (in hrs) .....

6. For what purpose these labourer's were used?

Purpose ....

....

7. Daily wage rate .....

8. In what form you gave the wage

i) Money (Y/N)

ii) Crops (Y/N)

iii) Crop residues (Y/N)

iv) Any other (Specify .....) (Y/N)

9. How much total money as wage did you pay? .....

10. How much total crop/crop residues did you give? .....

11. Any other (Specify .....) as wage .....

Question: If you are a labourer, please answer the following questions.

12. Did you work for any household within the village? (Y/N)

13. If yes, please fill up the following table

Name of the landlord	Head of the household
.....	.....
.....	.....
.....	.....
.....	.....
.....	.....

14. In what form did you receive the wages :

Money (Quantity) .....

Crops (Quantity) .....

Crop residues (Quantity) .....

Any other (Specify .....) (Quantity) .....

H. CROP PARTICULARS
(For the last cropping season only)

Sl No.	Crop particulars	Crop 1	Crop 2	Crop 3	Crop 4
1.	Crops sown				
2.	Local/High yielding variety				
3.	Net crop area				
4.	Net irrigated area				
5.	Total production				
6.	Given outside as wage/rent				
7.	Obtained from outside as wage/rent				
8.	Sold outside				
9.	Price at which sold				

10.	Total stock for consumption
	i) in household
	ii) for seeds
	iii) for animals
11.	Straw to grain ratio

I. FOODGRAIN CONSUMPTION

Sl No.	Foodgrain	Total consumption daily		Quantity purchased	Price paid	Received as wage	Total qty. received
		Human	Animal				
1.	Wheat						
2.	Rice						
3.	Guar						
4.	Bajra						
5.	Jowar						
6.	Maize						
7.	Pulse : Chana						
8.	Pulse : Moong						
9.	Pulse : Urad						
10.	Pulse : Arhar						
11.	Any other (Specify)						

J. HOUSEHOLD ENERGY CONSUMPTION (Traditional)

End use/Traditional fuel	Yesterday's consumption	Source of obtaining	Distance covered	Total Man hrs spent	Remarks
Cooking :					
1. Dung cakes					
2. Logs					
3. Twigs/branches					
4. Crop residues					
5. Any other					
Water heating :					
6. Dung cakes					
7. Logs					
8. Twigs/branches					
9. Crop residues					
10. Any other					
Space Heating :					
11. Dung cakes					
12. Logs					
13. Twigs/branches					
14. Crop residues					
15. Any other					

K. HOUSEHOLD ENERGY CONSUMPTION (Non-Traditional)

Use/ Non-traditional fuel	Fuel type	Units consumed last reporting month	Value (Rs.)	Hrs per day	Rem
Cooking	1. Kerosene 2. Electricity 3. Coal 4. Coke 5. Charcoal				
Water Heating	6. Kerosene 7. Electricity 8. Coal 9. Coke 10. Charcoal				
Lighting	11. Kerosene 12. Electricity				
Space heating	13. Electricity 14. Coal/Coke				
Vehicles	15. Petrol 16. Diesel				
Any other (Specify .....)					

L. SOURCES OF COLLECTION

Sources of collection	Dung	Logs	Twigs/ straws	Dry leaves	Vegetable wastes
1. Own farm					
2. Road side					
3. Nearby forest					
4. Other's farm					
5. As wages					
6. In exchange					

M. FERTILIZERS AND MANURES
(For the last cropping season only)

Chemical Fertilizers

Name	Quantity (Qtls)	Value (Rs.)	Unit Conversion
1.			
2.			
3.			
4.			

Organic Manures

Type	Source of obtaining	Quantity (Qtls)	Value (Rs)	Unit Conversion
5.				
6.				
7.				
8.				

N. CHULHAS OR COOKSTOVES PARTICULARS

Type	Used for	Material	Self made/ purchased	If purchased when at what price	Portable
1.					
2.					
3.					
4.					

O. TIME SPENT IN COLLECTION ACTIVITIES

Activities	Time spent per day (hrs)		Total number of persons involved	
	Young	Adult	Young	Adult
1. Dung collection				
2. Making of dung cakes				
3. Crop residue collection				
4. For cooking				
5. Agricultural waste collection				
6. Twigs/branches collection				
7. Logs collection				
8. After animals				
9. Any other (Specify .....)				

P. NEW AND RENEWABLE ENERGY DEVICES

1. Have you ever installed new/renewable energy devices? (Y/N)

2. If yes, please fill up the following table

Name of devices	Number	Size	Type	Application	Remarks
Biogas plant					
3. Family size					
4. Community size					
5. Institutional type					
6. Windmills					

Solar thermal Devices

7. Cookers
8. Water heaters
9. Crop dryers
10. Any other (Specify)

Solar photovoltaic Systems

11. Pump
12. Lighting unit
13. TV/Radio
14. Any other (Specify)

Biomass

15. Energy plantations
16. Gasifier
17. Improved wood stoves/chulhas
18. Briquetted charcoal making plants

Q. INCOME

1. Average daily expenditure per day per household .....

2. Total monthly income of the household from services by household members (Rs) .....

3. Total seasonal income in :

   i) Kharif season (Rs) .....

   ii) Zaid season (Rs) .....

   iii) Rabi season (Rs) .....

4. Income earned by any other means (Specify) (Rs) .....